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TABULATED CROSS SECTIONS FOR HYDROGEN
AND HELIUM PARTICLES PRODUCED BY
62- AND 29-MeV PROTONS ON ^{197}Au

F. E. Bertrand
R. W. Peelle

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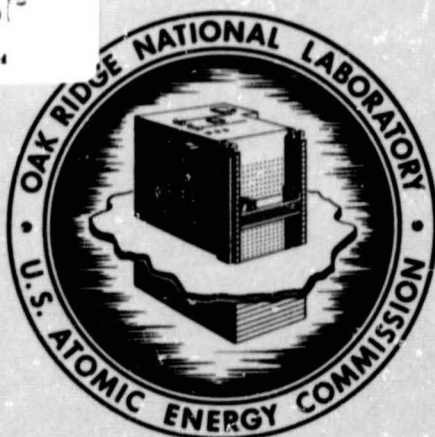
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PRODUCED BY 62- AND 29-MeV PROTONS ON ^{197}Au

F. E. Bertrand^a and R. W. Peelle

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^aOn leave from the Department of Physics, University of Southern California, Los Angeles, California

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ABSTRACT

Tabulated differential cross sections are presented for the production spectra of proton, deuteron, triton, helium-3, and alpha particles from ^{197}Au bombarded by approximately 62- and 29-MeV protons. Continuum cross sections are given at 6 angles from 15 through 125 degrees, over the energy region down to a low-energy cutoff of 3 to 13 MeV which depends on particle type.

The differential cross sections for the production of proton, deuteron, triton, helium-3, and alpha particles produced by bombardment of ^{197}Au by 61.5- and 28.8-MeV protons were measured over a secondary energy range from ~ 3 to 62 MeV. The details of the experimental system and data analysis have been reported elsewhere,¹ as has been data from other targets.² This report gives the tabulated cross sections for the secondary charged particles.

The incident protons were accelerated by the Oak Ridge Isochronous Cyclotron, momentum analyzed in a 153-deg magnet, and focused on the target in a spot of approximately 8-mm diameter. The reaction particles from the target were detected in an all solid-state, three-counter telescope utilizing Li-drifted Germanium as the total absorption detector.³ The overall energy resolution was approximately 200 keV for most of the data; however, the resolution of some of the data was 400 to 500 keV due

to detector failure. The secondary particle type was determined by a combination of ΔE versus E and flight time versus E methods which permitted unambiguous identification over the entire reported energy range. Data was obtained from four ADC's for each event, processed in an on-line PDP-8 computer, and written on magnetic tape. The data was analyzed on the ORNL IBM-360 and CDC-1604 computers and on the PDP-8.

The gold target used was commercial gold foil of thickness 7.08 ± 0.0078 mg/cm² with a nonuniformity over the area bombarded of $\pm 1.5\%$. The low-energy cutoffs for the data were determined largely by the presence of copper contaminant in the gold target. The contaminant was detected through the observation of a low-energy evaporation peak (~ 8 MeV) in the secondary alpha particle data, and it was found by flame emission spectroscopic analysis that the target contained approximately 0.2 ± 0.004 mole % of copper, in reasonable agreement with the magnitude of the contaminant peak observed, when it was assumed that the alpha evaporation peak from copper has the same cross section as that for ⁵⁴Fe for which the alpha evaporation cross section has been measured.¹ The gold low-energy cutoffs were set above the contaminant peak as well as possible; however, as is observed in the figures, the spectral magnitudes do not go to zero at low energies as might be expected. The contribution of the contaminant to the continuum cross sections is negligible at higher energies, but does affect by up to $\sim 25\%$ the few lowest energy bins shown for the proton and alpha-particle spectra. The low-energy cutoffs for the data are listed in Table 1.

Data was obtained at 15, 30, 50, 75, 99, and 124 degrees at 62 MeV incident energy, and at 30, 60, 90, and 125 degrees at 29 MeV. Since the maximum number of angles was six and since much of that data suffered from poor energy resolution, cross sections for the excitation of discrete levels in the spectra are not given except for the elastic cross sections which are listed in Table 2. The 62-MeV secondary proton data at the angles of 30, 75, and 124 degrees is undetermined between the energies of ~ 24 and 34 MeV due to a temporary high threshold on the fast signals from the second ΔE detector. The cross sections listed for the affected regions are estimated on the basis of the magnitude and shape of the spectra above and below the uncertain region, and the uncertainty in these regions is considered to be $\pm 10\%$. The resolution of the elastic proton peak at 15 degrees for the 62-MeV data was so poor that the total inelastic proton cross section at 15 degrees contains a few percent of the elastic peak, and the elastic cross section is in doubt by $\pm 20\%$.

Table 3 lists the experimental parameters and the assigned systematic uncertainties for the data in this report. A list of factors by which counts are multiplied to give laboratory system millibarns (steradian)⁻¹ are given for each angle in Table 4.

The gold data have been corrected for the effects of: nuclear reactions in the germanium detector, collimator edge penetration, "dead" layer in the path of the scattered particles, multiple scattering of the secondary protons by the ΔE detectors, and energy loss from the scattered particles in the target. These corrections are described in reference 1.

The magnitudes of the "tail" corrections for nuclear reactions in the germanium detector and for collimator edge penetration are both dependent upon the number and spectral distribution of recorded counts. These corrections are significant only for protons at scattering angles less than about 30 degrees, where the spectra are dominated by strong elastic scattering, and generally fall rapidly with angle within that range. The uncertainty in the correction for collimator penetration is taken as 20% of the correction, which is approximately proportional to pulse height. This uncertainty is significant only at 15 deg as shown in the table below. The uncertainty in the reaction tail correction is taken as 25% of the correction, which rises from zero to its full value between 37 and 45 MeV and then remains roughly constant up to the elastic peak. The cross section uncertainty in the correction is tabulated below for the runs in which it is significant. These uncertainties must be combined with the overall uncertainties of Table 3 and with statistical uncertainties.

<u>Angle</u>	<u>Uncertainty from reaction tail correction of 45 MeV</u>	<u>Uncertainty from collimator edge penetration at 45 MeV</u>
	<u>62 MeV</u>	
15	$\pm 0.3 \text{ mb(ster-MeV)}^{-1}$	$\pm 0.09 \text{ mb(ster-MeV)}^{-1}$
30	$\pm 0.01 \text{ mb(ster-MeV)}^{-1}$	
	<u>29 MeV</u>	
30	$\pm 0.02 \text{ mb(ster-MeV)}^{-1}$	

Figures 1-10 show the angle-integrated spectra for proton, deuteron, triton, helium-3, and alpha particles from ^{197}Au bombarded by 61.5- and 28.8-MeV protons, respectively. The integrals over angle were performed using a trapezoidal quadrature where the cross section at zero degrees was assumed to be equal to the cross section at the smallest data angle and the 180-deg cross section was assumed to be equal to the cross section at the largest angle at which data was obtained. The angle integrals for the 28.8-MeV data are low in magnitude due to the lack of small angle (15 deg) data. By omitting the 15-deg data from the 62-MeV integral it was found that the 29-MeV integrals shown for protons and deuterons can be considered low by 17% and 14%, respectively, when integrated over energy. The error is much smaller ($<5\%$) for the other particles. The broad peaks at the high energy end of some of the figures include averages over observed level structure. The figures, particularly Fig. 3, show the local effect of the nickel foil which covered the germanium detector at about 9-, 12-, and 15-MeV for protons, deuterons, and tritons. Particles in these regions may be registered at the wrong energy. The proton angle integrals do not include the elastic scattering and the low-energy cutoff for each plot is that given in Table 8.

Tables 5 and 6 are lists of the binned cross sections integrated over angle for each particle type for 62- and 29-MeV protons, respectively, in units of millibarns/MeV; the energy listed is for the lower edge of each bin. Table 7 shows the energy-integrated laboratory cross section, in units of millibarns/steradian, and the average energies in MeV, at each angle for both incident energies. The total cross sections in millibarns, average energies in MeV, and average forward momenta in MeV/c, for the

observed particles are listed in Table 8 along with low-energy cutoffs for the data. The secondary proton cross sections listed do not include the elastic scattering cross sections, while the cross sections for the other secondary particles include all observed events.

The uncertainties listed on all tables (unless otherwise noted) are based on Poisson statistics only and should be used in combination with the combined overall uncertainty (5%) shown on Table 3.

Tables 9-13 list for each angle the laboratory cross sections for proton, deuteron, triton, helium-3, and alpha particle production from 61.5-MeV protons on ^{197}Au , binned in 0.4-MeV wide bins at low energies and 1-MeV wide bins elsewhere, in units of millibarns (steradian-MeV) $^{-1}$. The bin energies listed are the center of the bins. Tables 14-18 list the cross sections for the above particles produced by 28.8-MeV incident protons. Cross sections are listed for energies above the cutoffs listed in Table 7.

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1. F. E. Bertrand et al, Differential Cross Sections for the Charged Particles Produced by 60-MeV Protons on Carbon, Iron, and Bismuth, ORNL-4274 (1968).

F. E. Bertrand and R. W. Peelle, Tabulated Cross Sections for Hydrogen and Helium Particles Produced by 62-MeV Protons on ^{89}Y , ORNL-4450, (1969).
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F. E. Bertrand and R. W. Peelle, Tabulated Cross Sections for Hydrogen and Helium Particles Produced by 61-MeV Protons on ^{56}Fe , ORNL-4456 (1969).
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Table 1
Low-Energy Cutoffs
 ^{197}Au

<u>Particle Type</u>	<u>Low-Energy Cutoff</u>	<u>Reason</u>
	<u>61.5 MeV</u>	
Proton	3.6 MeV	Contaminant in target
Deuteron	4.9 MeV	Contaminant in target
Triton	6.4 MeV	Mass-3 ambiguity in TOF
Helium-3	12.6 MeV	Contaminant in target
Alpha	12.5 MeV	Contaminant in target
	<u>28.8 MeV</u>	
Proton	3.6 MeV	Contaminant in target
Deuteron	4.8 MeV	Contaminant in target
Triton	6.4 MeV	Mass-3 ambiguity in TOF
Helium-3	12.5 MeV	No visible data in TOF
Alpha	12.3 MeV	Contaminant in target

Table 2.

Tabulated Differential Cross Sections

 $^{197}\text{Au}(p,p)^{197}\text{Au}$
 Elastic Scattering

C.M.Angle (deg)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty (±%)
$E_p = 61.5 \text{ MeV}$		
15	2600	20
30	34.8	0.4
50	15.5	0.5
75	0.35	10
99	0.32	3
124	0.051	12
$E_p = 28.8 \text{ MeV}$		
30	961	0.3
60	20.8	0.5
90	2.35	2.1
130	1.44	2.1

Table 3.
Experimental Parameters and Uncertainties

^{197}Au Target	
Thickness	$7.02 \pm 0.07 \text{ mg/cm}^2$
Nonuniformity	$\pm 1.5\%$
Beam Energies	$61.5 \pm 0.1 \text{ MeV}$ $28.8 \pm 0.1 \text{ MeV}$
Uncertainty in number of Protons striking target	$\pm 1\%$
Uncertainty from dead time correction	$\pm 1.5\%$
Collimator	
Material	Ta
Thickness (62,28 MeV)	0.432 cm, 0.013 cm
Area (cm^2)	$0.522 \pm 1.5\%$
Distance (cm)	$45.8 \pm 1\%$
Detector angle	$\pm 0.5 \text{ deg}$
Zero angle	$\pm 0.5 \text{ deg}$
Angular resolution	$\pm 1.2 \text{ deg}$
Target angle	$\pm 0.5 \text{ deg}$
Beam spot diameter	0.8 cm
Beam spot "walk"	$\pm 0.4 \text{ cm}$
Collimator misalignment at chamber center	$\pm 0.5 \text{ cm}$
K (for collimator scattering correction)	2.2
Uncertainty in various corrections to data	$\pm 2\%$
Combined absolute uncertainty	$\pm 5\%$
For all ^3He and for cases where the cross sections are unusually small	$\pm 10\%$

Table 4

List of Angles, Run Numbers, and Factors

 ^{197}Au

<u>Lab Angle (deg)</u>	<u>Run Number</u> <u>62 MeV</u>	<u>Factor</u> ^a
15	0126	$6.407 \times 10(-3)^b$
30	0131	$6.113 \times 10(-4)$
50	0137	$5.215 \times 10(-4)$
75	0142	$6.098 \times 10(-4)$
99	0132	$3.206 \times 10(-4)$
124	0136	$7.315 \times 10(-4)$
	<u>29 MeV</u>	
30	0023	$7.386 \times 10(-3)$
60	0022	$1.048 \times 10(-3)$
90	0016	$4.527 \times 10(-4)$
130	0021	$5.585 \times 10(-4)$

a) Numbers by which the counts are multiplied to give millibarn/steradian

b) Read as 6.407×10^{-3}

Table 5. Angle-Integrated Cross Sections from 61.5 MeV

Bin Energy ^a (MeV)	Cross Section (mb/MeV)	Error (mb/MeV)	Bin Energy ^a (MeV)	Cross Section (mb/MeV)	Error (mb/MeV)	Bin Energy ^a (MeV)	Cross Section (mb/MeV)	Error (mb/MeV)
<u>Proton</u>			<u>Deuteron</u>			<u>Triton</u>		
3.64	0.79	0.076	4.83	0.74	0.013	6.34	0.038	0.011
4.04	1.81	0.104	5.83	0.097	0.013	7.35	0.087	0.013
4.44	1.68	0.099	6.89	0.21	0.019	8.35	0.197	0.018
4.84	2.27	0.074	7.84	0.37	0.025	9.35	0.410	0.025
5.85	3.63	0.095	8.84	0.76	0.037	10.36	0.534	0.030
6.85	4.66	0.103	9.84	1.04	0.042	11.36	0.674	0.032
7.85	7.05	0.121	10.84	1.48	0.049	12.36	0.730	0.034
8.86	8.30	0.127	11.84	1.54	0.051	13.37	0.599	0.031
9.86	12.66	0.152	12.84	1.84	0.054	14.37	0.752	0.033
10.86	13.40	0.154	13.85	2.00	0.056	15.37	0.881	0.036
11.87	13.87	0.156	14.85	2.08	0.057	16.37	0.938	0.038
12.87	14.28	0.157	15.85	2.07	0.057	17.38	0.932	0.037
13.87	14.92	0.160	16.85	2.15	0.058	18.38	0.835	0.027
14.88	15.05	0.161	17.85	2.13	0.056	20.00	0.819	0.025
15.86	15.22	0.161	18.85	2.19	0.054	22.00	0.696	0.023
16.89	15.30	0.161	20.00	2.10	0.040	24.00	0.665	0.022
17.89	15.13	0.160	22.00	2.08	0.040	26.00	0.578	0.021
18.89	14.90	0.151	24.00	1.95	0.037	28.00	0.520	0.020
20.00	14.40	0.111	26.00	1.86	0.037	30.00	0.487	0.019
22.00	13.98	0.108	28.00	1.76	0.036	32.00	0.427	0.018
24.00	14.03	0.109	30.00	1.64	0.035	34.00	0.368	0.017
26.00	14.08	0.109	32.00	1.58	0.035	36.00	0.357	0.017
28.00	13.92	0.109	34.00	1.55	0.035	38.00	0.328	0.016
30.00	13.59	0.107	36.00	1.42	0.033	40.00	0.285	0.015
32.00	13.24	0.106	38.00	1.37	0.033	42.00	0.267	0.015
34.00	13.29	0.106	40.00	1.40	0.034	44.00	0.258	0.015
36.00	12.34	0.102	42.00	1.39	0.035	46.00	0.203	0.013
38.00	12.47	0.104	44.00	1.46	0.037	48.00	0.143	0.011
40.00	12.08	0.104	46.00	1.54	0.039	50.00	0.120	0.010
42.00	11.41	0.101	48.00	1.71	0.025	52.00	0.045	0.006
44.00	10.92	0.099	50.00	2.01	0.048	54.00	0.005	0.002
46.00	10.88	0.099	52.00	2.70	0.055	56.00	0.000	0.001
48.00	10.22	0.096	54.00	3.28	0.056	58.00	0.003	0.002
50.00	9.35	0.093	56.00	2.06	0.410	60.00	0.001	0.002
52.00	9.20	0.096	56.03			62.00	0	0
54.00	9.23	0.097				62.03		
56.00	9.10	0.096						
58.00	7.85	0.093						
60.00	4.49	0.063						
63.03								

(continued on next page)

Table 5. (continued)

Bin Energy ^a (MeV)	Cross Section (mb/MeV)	Error (mb/MeV)	Bin Energy ^a (MeV)	Cross Section (mb/MeV)	Error (mb/MeV)	Bin Energy ^a (MeV)	Cross Section (mb/MeV)	Error (mb/MeV)
<u>Helium-3</u>			<u>Alpha</u>					
12.49	0.011	0.005	12.49	0.042	0.011			
13.49	0.012	0.005	13.22	0.136	0.020			
14.50	0.008	0.004	14.22	0.291	0.023			
15.56	0.009	0.004	15.22	0.668	0.036			
16.50	0.020	0.006	16.22	1.213	0.048			
17.56	0.010	0.004	17.23	1.712	0.056			
18.50	0.014	0.004	18.23	2.345	0.048			
20.00	0.026	0.004	20.00	2.110	0.042			
22.00	0.036	0.005	22.00	1.613	0.035			
24.00	0.049	0.006	24.00	1.393	0.032			
26.00	0.062	0.007	26.00	1.150	0.029			
28.00	0.074	0.007	28.00	0.968	0.026			
30.00	0.088	0.008	30.00	0.863	0.025			
32.00	0.066	0.007	32.00	0.642	0.021			
34.00	0.073	0.007	34.00	0.554	0.021			
36.00	0.083	0.008	36.00	0.364	0.017			
38.00	0.069	0.008	38.00	0.413	0.017			
40.00	0.066	0.007	40.00	0.372	0.017			
42.00	0.070	0.008	42.00	0.325	0.016			
44.00	0.081	0.009	44.00	0.265	0.014			
46.00	0.064	0.008	46.00	0.186	0.012			
48.00	0.067	0.008	48.00	0.165	0.011			
50.00	0.072	0.007	50.00	0.153	0.011			
52.00	0.043	0.006	52.00	0.118	0.010			
54.00	0.003	0.001	54.00	0.092	0.008			
56.00	0	0	56.00	0.071	0.007			
58.00	0	0	58.00	0.059	0.006			
60.00	0.002	0.002	60.00	0.034	0.005			
62.00	0	0	62.00	0.013	0.041			
62.03			62.03					

^a) Bin energy listed is the low-energy edge of the bin. The highest bin energy listed is the upper edge of the last bin.

Table 6. Angle-Integrated Cross Sections from 28.8 MeV

Bin Energy ^a (MeV)	Cross Section (mb/MeV)	Error (mb/MeV)	Bin Energy ^a (MeV)	Cross Section (mb/MeV)	Error (mb/MeV)	Bin Energy ^a (MeV)	Cross Section (mb/MeV)	Error (mb/MeV)
<u>Proton</u>			<u>Deuteron</u>			<u>Helium-3</u>		
3.69	2.05	0.250	4.84	0.063	0.015	12.72	0.003	0.007
4.09	3.07	0.268	5.85	0.079	0.023	13.73	0.012	0.013
4.49	3.15	0.271	6.85	0.123	0.029	14.73	0	0
4.89	3.11	0.173	7.85	0.208	0.037	15.73	0.001	0.001
5.90	3.46	0.188	8.86	0.391	0.049	16.74	0.002	0.002
6.90	4.56	0.214	9.86	0.696	0.068	17.74	0.003	0.003
7.90	6.30	0.238	10.87	1.004	0.079	18.74	0.011	0.008
8.91	7.12	0.234	11.87	0.868	0.071	20.00	0.006	0.006
9.91	13.36	0.302	12.87	1.634	0.111	22.00	0	0
10.92	13.36	0.312	13.88	1.649	0.102	24.00	0	0
11.92	12.93	0.309	14.88	2.099	0.125	26.00	0	0
12.92	13.79	0.329	15.88	2.341	0.135	28.00	0	0
13.93	13.18	0.315	16.89	2.450	0.143	30.00	0	0
14.93	13.83	0.326	17.89	2.931	0.166	30.03		
15.93	14.69	0.346	18.89	3.002	0.159			
16.94	14.31	0.346	20.00	8.415	0.199			
17.94	12.91	0.330	22.00	14.736	0.389			
18.95	12.67	0.325	23.08					
20.00	12.36	0.233					<u>Alpha</u>	
22.00	12.32	0.239		<u>Triton</u>		12.37	0.041	0.021
24.00	10.46	0.225				13.37	0.045	0.021
26.00	8.65	0.213	6.40	0.009	0.005	14.38	0.051	0.020
28.00	25.90	1.049	7.40	0.015	0.007	15.38	0.073	0.013
28.31			8.41	0.078	0.020	16.39	0.113	0.020
			9.41	0.174	0.035	17.39	0.210	0.034
			10.41	0.369	0.052	18.39	0.247	0.031
			11.42	0.502	0.062	20.00	0.399	0.040
			12.42	0.610	0.065	22.00	0.505	0.044
			13.42	0.724	0.077	24.00	0.508	0.045
			14.43	0.688	0.075	26.00	0.561	0.051
			15.43	0.702	0.073	28.00	0.480	0.047
			16.44	0.668	0.072	30.00	0.389	0.387
			17.44	0.835	0.081	30.03		
			18.44	1.346	0.085			
			20.00	1.173	0.077			
			22.00	1.423	0.167			
			22.63					

a) Bin energy listed is the low-energy edge of the bin. The highest bin energy listed is the upper edge of the last bin.

Table 7. Energy Integrated Differential Cross Sections

 ^{197}Au

Lab Angle deg	Proton ^a			Deuteron			Triton			Helium-3			Alpha		
	$\sigma \pm \Delta\sigma^c$ (mb/sr)	\bar{E}^d (MeV)	COE ^b (MeV)	$\sigma \pm \Delta\sigma^c$ (mb/sr)	\bar{E}^d (MeV)	COE ^b (MeV)	$\sigma \pm \Delta\sigma^c$ (mb/sr)	\bar{E}^d (MeV)	COE ^b (MeV)	$\sigma \pm \Delta\sigma^c$ (mb/sr)	\bar{E}^d (MeV)	COE ^b (MeV)	$\sigma \pm \Delta\sigma^c$ (mb/sr)	\bar{E}^d (MeV)	COE ^b (MeV)
<u>61.5 MeV Protons Incident</u>															
15	338.9 ± 1.5	36.6	3.8	42.3 ± 0.5	41.1	4.9	6.69 ± 0.2	30.3	6.5	1.01 ± 0.08	40.0	12.6	6.30 ± 0.2	32.0	13.9
30	123.2 ± 2.4^e	36.4	3.7	20.3 ± 0.1	36.2	4.9	4.81 ± 0.1	28.6	6.4	0.59 ± 0.02	40.0	12.6	5.45 ± 0.06	31.2	13.8
50	81.5 ± 0.2	32.6	3.7	10.3 ± 0.1	31.3	4.8	2.86 ± 0.04	25.3	6.4	0.31 ± 0.01	36.1	12.5	3.74 ± 0.04	28.7	13.8
75	35.6 ± 0.7^e	27.6	3.7	4.6 ± 0.1	26.2	4.9	1.44 ± 0.03	22.7	6.4	0.12 ± 0.01	33.8	12.5	2.36 ± 0.04	25.7	12.2
99	21.0 ± 0.1	23.0	3.7	2.4 ± 0.1	23.1	4.9	0.79 ± 0.02	20.1	6.4	0.057 ± 0.004	32.2	12.6	1.78 ± 0.02	23.7	12.2
124	12.9 ± 0.24^e	19.8	3.7	1.4 ± 0.1	20.8	4.8	0.44 ± 0.02	18.3	6.4	0.024 ± 0.004	27.5	12.5	1.37 ± 0.03	21.7	12.1
<u>28.8 MeV Protons Incident</u>															
30	66.9 ± 0.7	18.2	3.7	14.8 ± 0.3	20.3	4.8	2.7 ± 0.1	18.2	6.3	0.02 ± 0.01	17.0	12.5	1.4 ± 0.1	24.6	12.1
60	21.5 ± 0.2	18.1	3.6	5.5 ± 0.1	19.4	4.8	1.1 ± 0.03	17.3	6.3	0.001 ± 0.001	19.0	12.5	0.6 ± 0.03	24.5	12.1
90	9.1 ± 0.1	16.7	3.7	1.5 ± 0.03	18.0	4.9	0.4 ± 0.01	16.7	6.4	0.002 ± 0.001	19.6	12.6	0.2 ± 0.01	22.9	12.4
130	8.3 ± 0.1	14.5	4.0	0.7 ± 0.02	16.6	5.2	0.2 ± 0.01	15.9	6.4	0.002 ± 0.001	18.7	13.5	0.2 ± 0.01	21.9	13.3

a) The proton cross sections do not include elastic scattering

b) COE \equiv Cutoff energy (low-energy)

c) These uncertainties are statistical only

d) Average energy

e) These errors include uncertainty in the cross sections at these angles - see text

Table 8. Total Cross Sections - ^{197}Au

Particle	$\sigma \pm \Delta\sigma$ (mb)	\bar{E} (MeV)	\bar{pc} (MeV)	Lower Energy Limit (MeV)
<u>61.5 MeV Protons Incident</u>				
Prot ^a	654.6 \pm 2.7	31.9	143.2	3.6
Deuteron	86.0 \pm 0.4	33.1	219.0	4.8
Triton	21.3 \pm 0.2	25.4	199.4	6.4
Helium-3	2.3 \pm 0.1	37.1	289.6	12.5
Alpha	32.0 \pm 0.2	27.0	157.9	12.6
<u>28.8 MeV Protons Incident</u> ^b				
Proton	259.6 \pm 1.5	17.5	86.9	3.6
Deuteron	52.6 \pm 0.7	19.5	161.3	4.8
Triton	10.7 \pm 0.02	17.5	165.1	6.4
Helium-3	0.05 \pm 0.02	17.8	147.9	12.7
Alpha	5.85 \pm 0.2	24.0	192.0	12.4

a) does not include elastic scattering

b) the angle integrals for the 28.8-MeV data are low in magnitude due to the lack of small angle (15 deg) data. By omitting the 15-deg data from the 62-MeV integrals it was found that the 28-MeV integrals listed above for protons and deuterons can be considered low by 17% and 14% respectively. The error is much smaller ($< 5\%$) for the other particles.

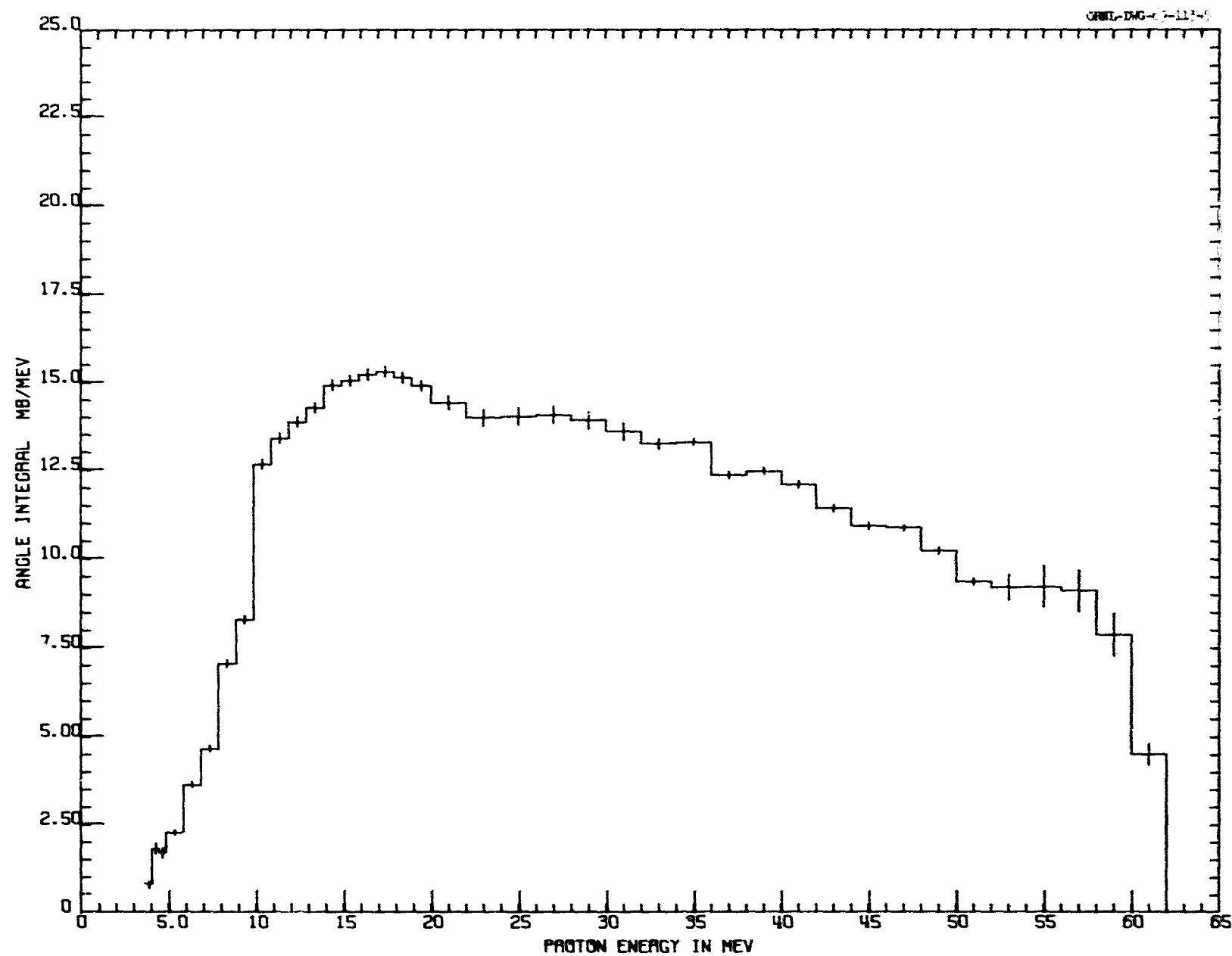


Fig. 1. Angle-integrated Proton Spectrum from ^{197}Au .
61.5-MeV Protons Incident
(Elastic Scattering not Included)

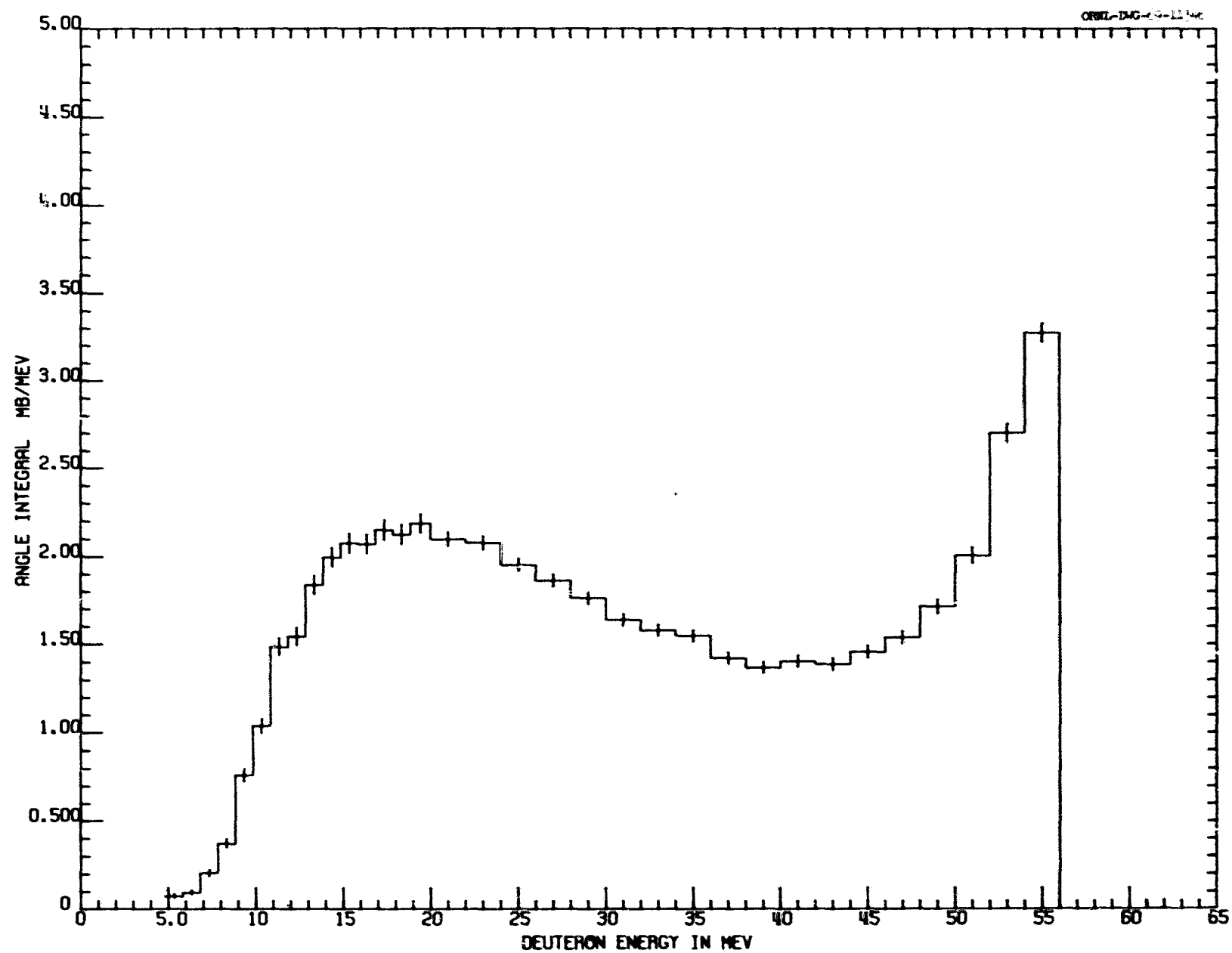


Fig. 2. Angle-integrated Deuteron Spectrum from ^{197}Au .
61.5-MeV Protons Incident

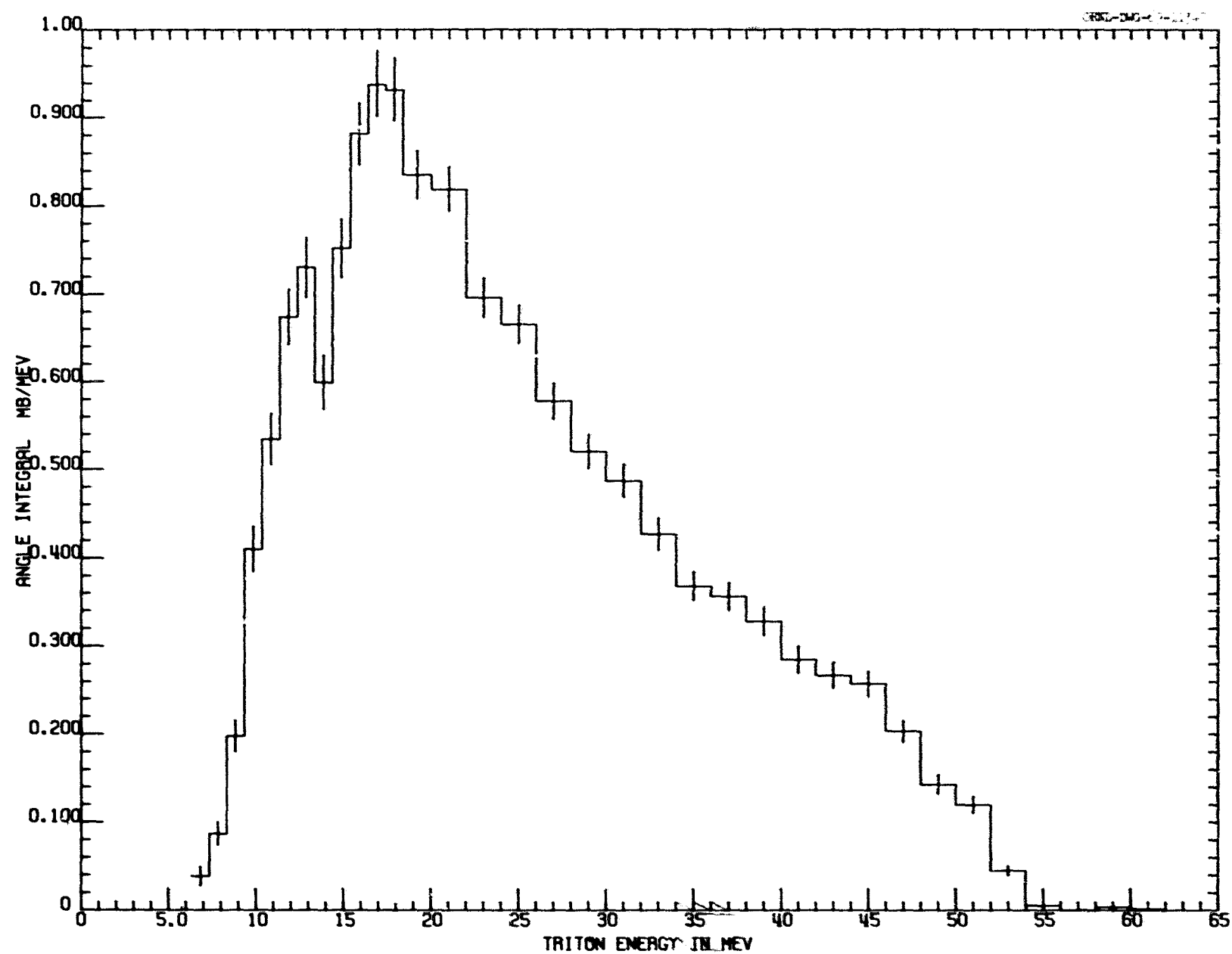


Fig. 3. Angle-integrated Triton Spectrum from ^{197}Au .
61.5-MeV Protons Incident

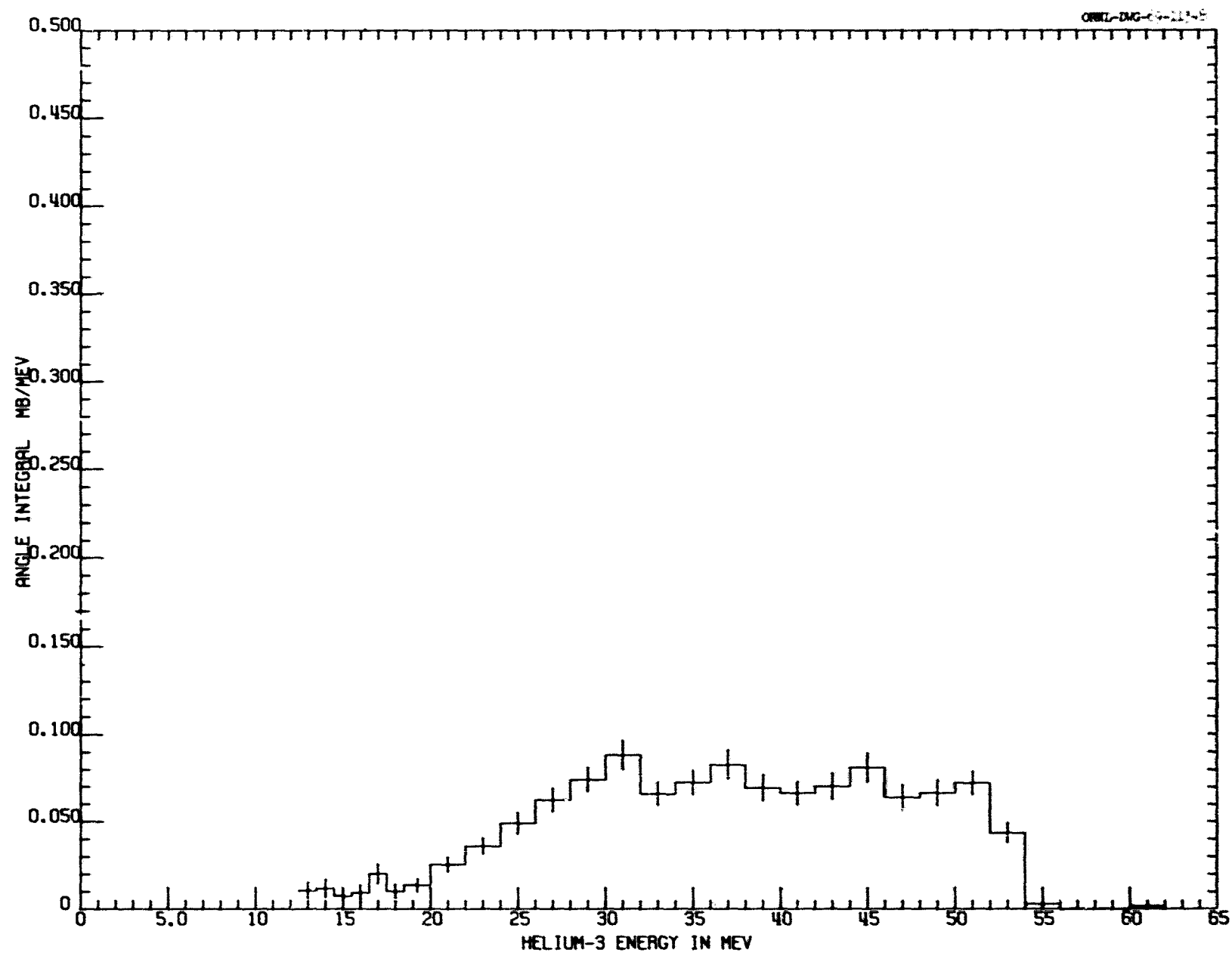


Fig. 4. Angle-integrated Helium-3 Spectrum from ^{197}Au .
61.5-MeV Protons Incident

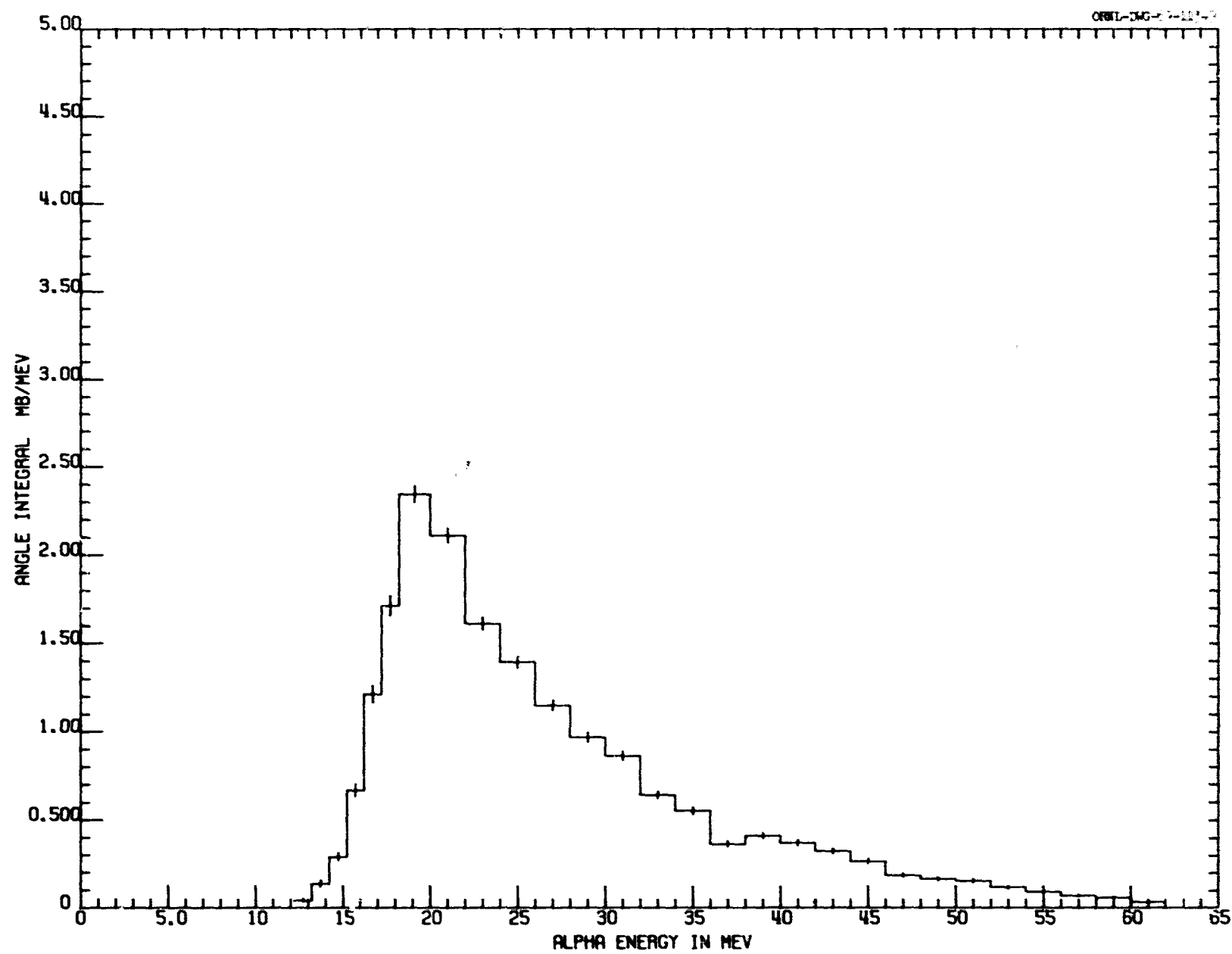


Fig. 5. Angle-integrated Alpha Spectrum from ^{197}Au .
61.5-MeV Protons Incident

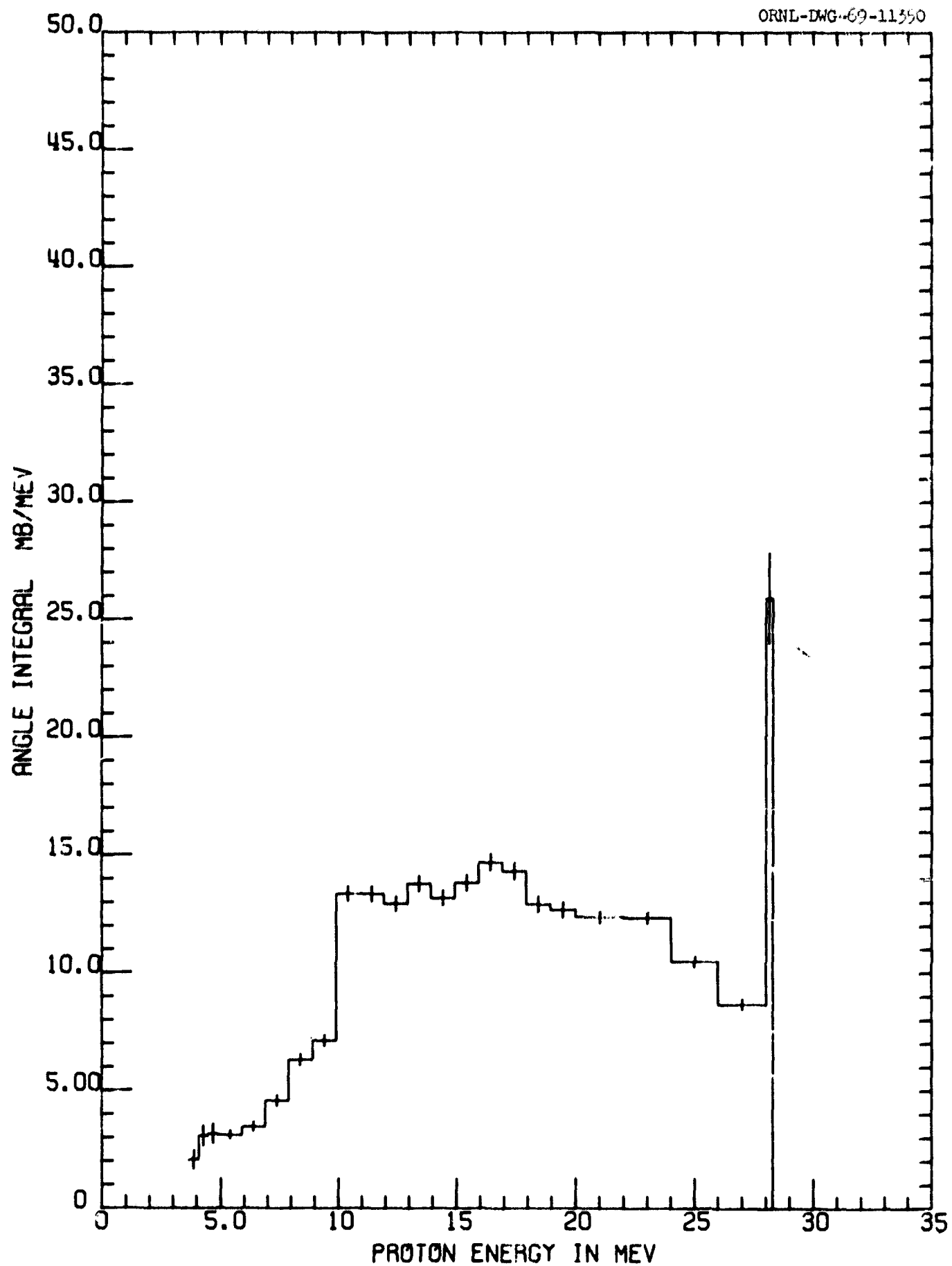


Fig. 6. Angle-integrated Proton Spectrum from ^{197}Au .
28.8-MeV Protons Incident

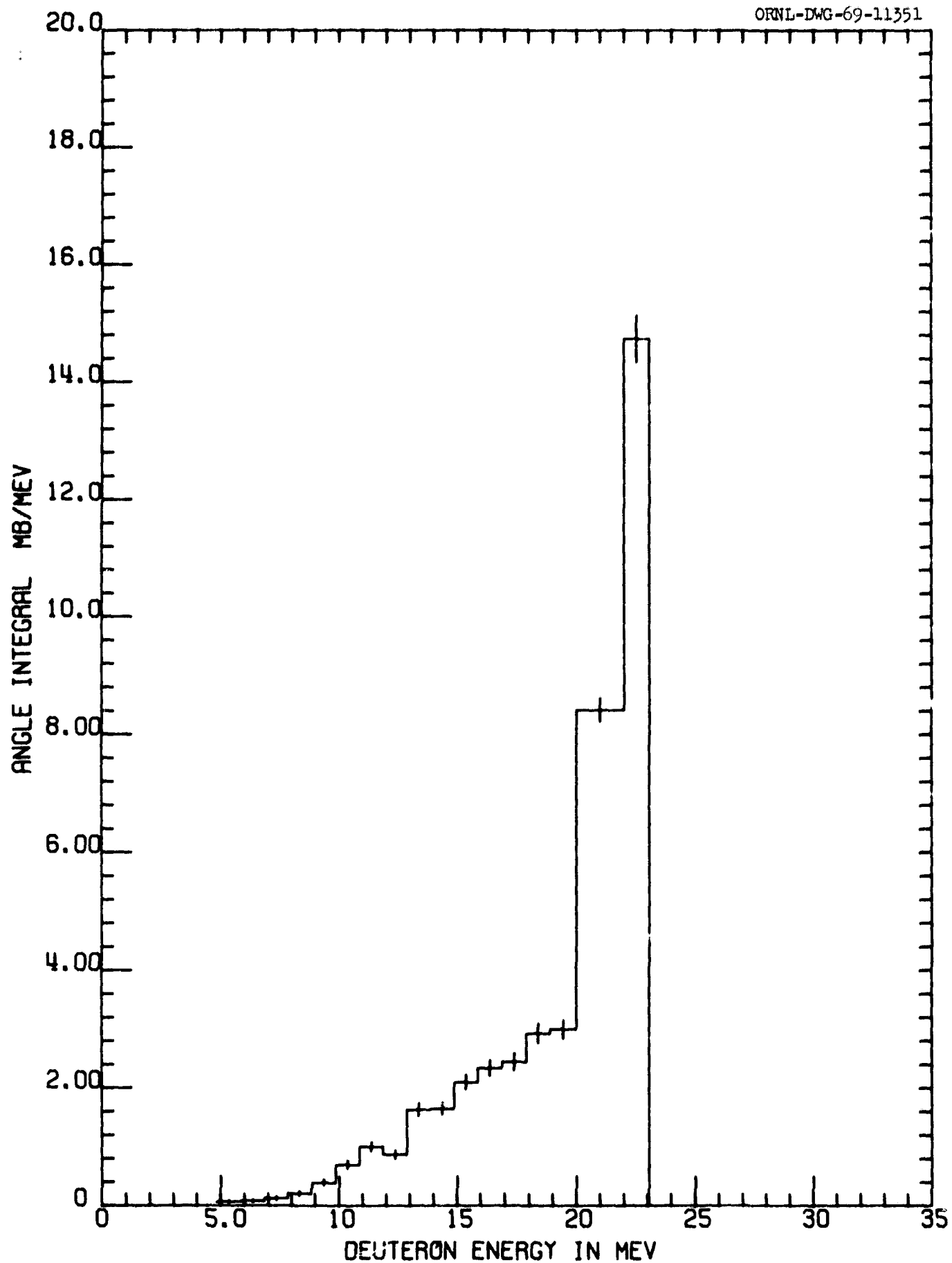


Fig. 7. Angle-integrated Deuteron Spectrum from ^{197}Au .
28.8-MeV Protons Incident

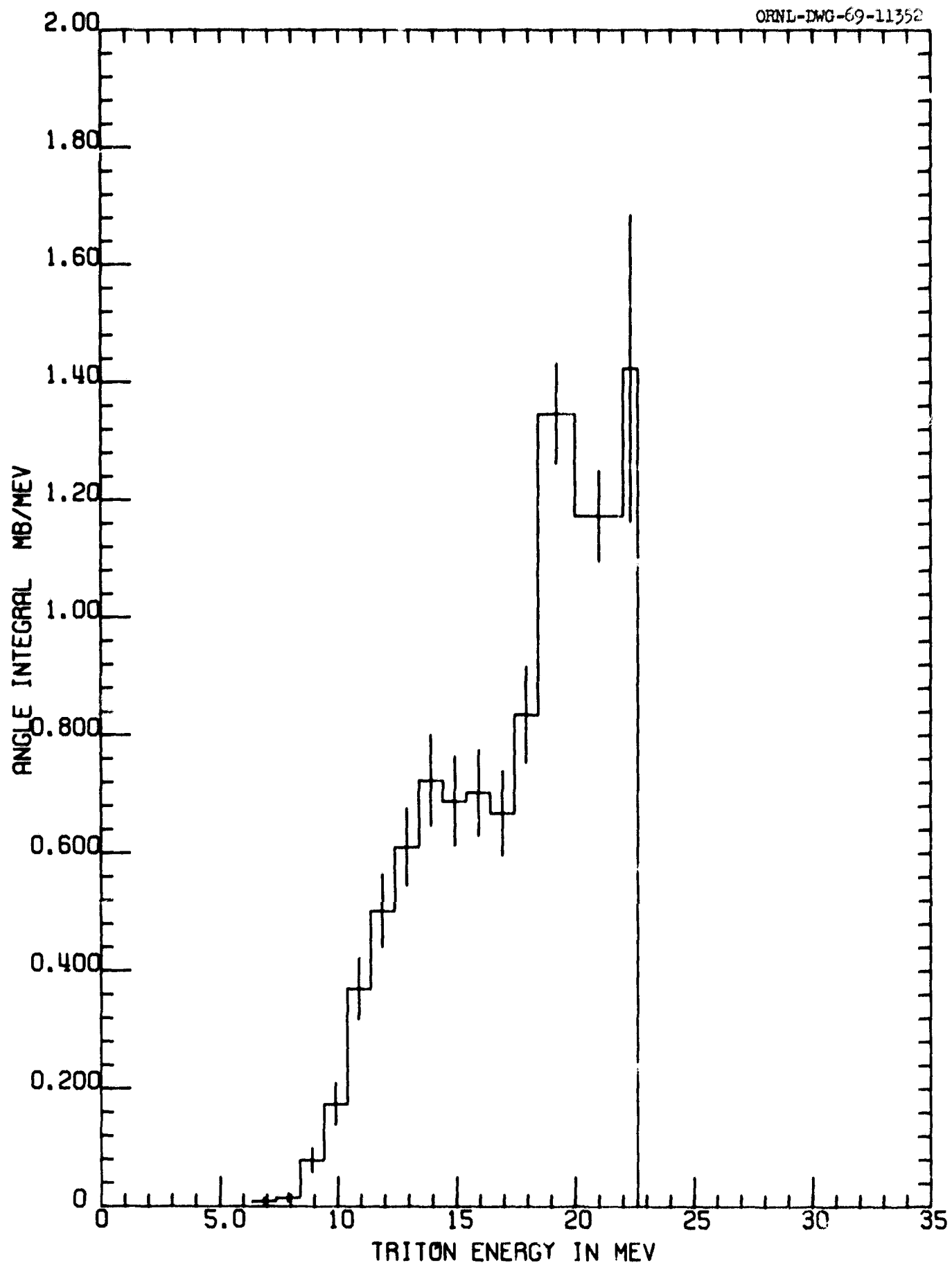


Fig. 8. Angle-integrated Triton Spectrum from ^{197}Au .
28.8-MeV Protons Incident

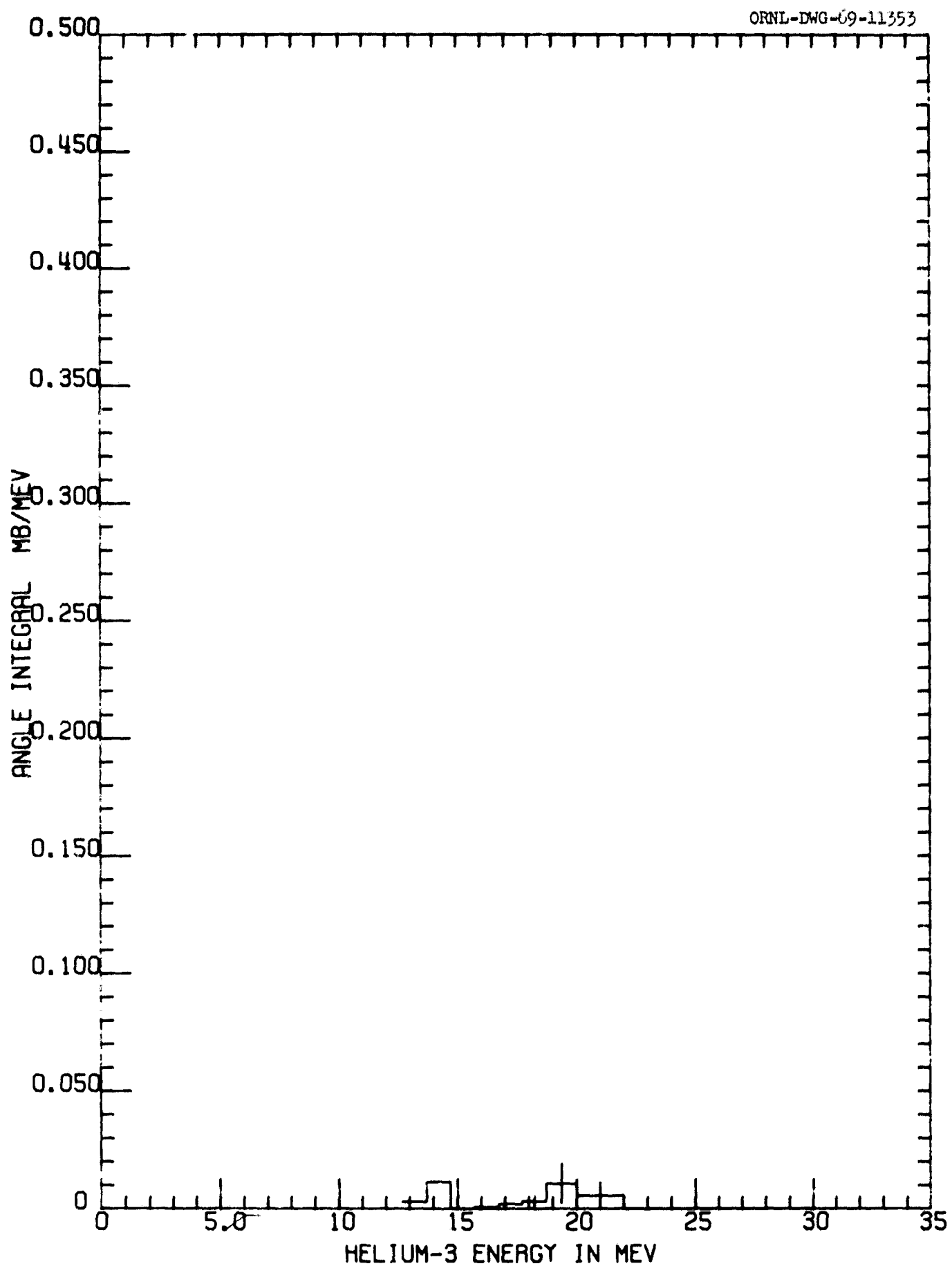


Fig. 9. Angle-integrated Helium-3 Spectrum from ^{197}Au .
28.8-MeV Protons Incident

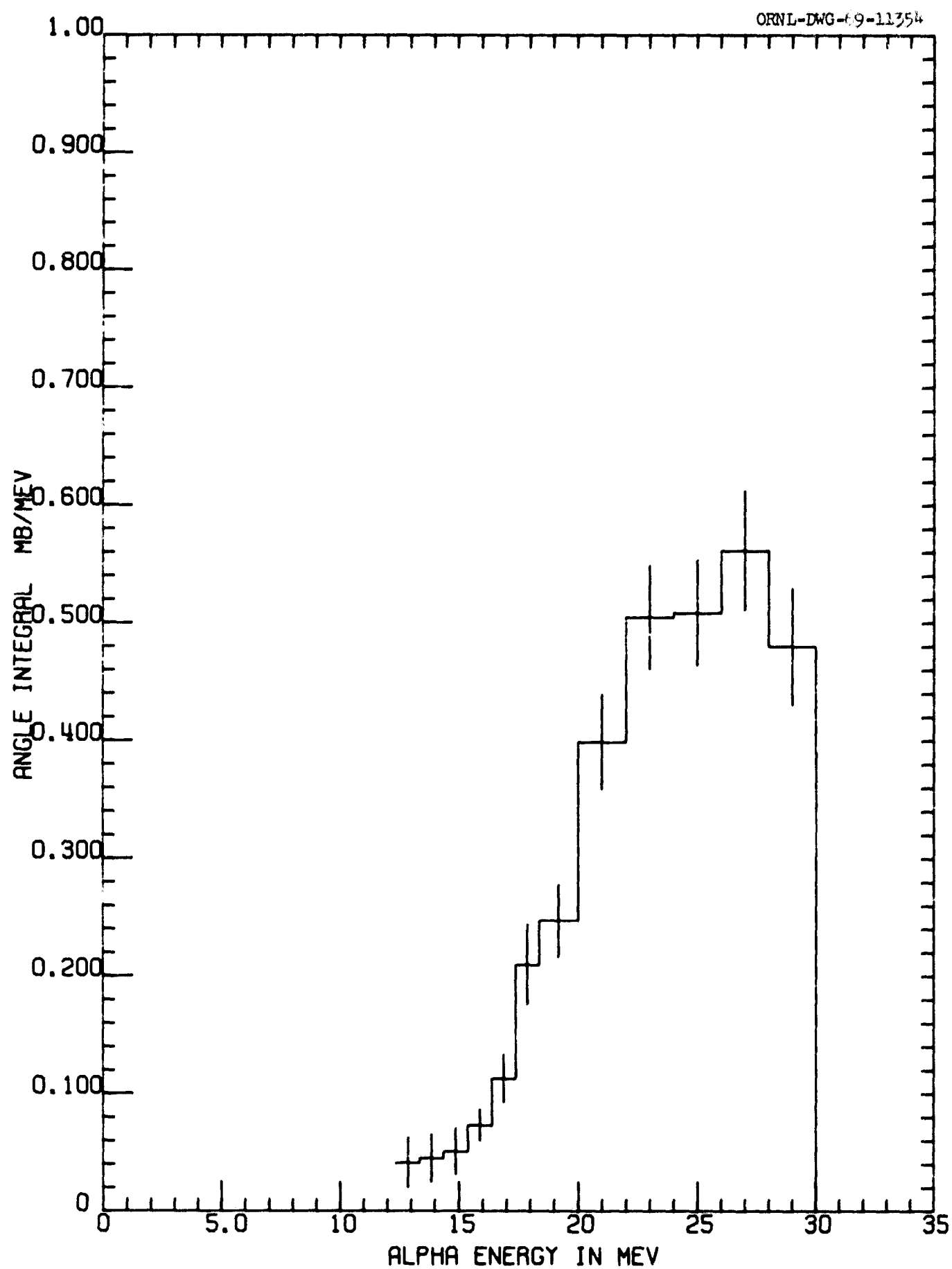


Fig. 10. Angle-integrated Alpha Spectrum from ^{197}Au .
28.8-MeV Protons Incident

Tabulated Cross Sections

61.5-MeV Protons Incident on ^{197}Au :

Proton production	Table 9	Pages 28-29
Deuteron production	Table 10	Pages 30-31
Triton production	Table 11	Pages 32-33
Helium-3 production	Table 12	Pages 34-35
Alpha particle production	Table 13	Pages 36-37

28.8-MeV Protons Incident on ^{197}Au :

Proton production	Table 14	Page 38
Deuteron production	Table 15	Page 39
Triton production	Table 16	Page 40
Helium-3 production	Table 17	Page 41
Alpha particle production	Table 18	Page 42

TABLE 9. PROTON FROM A = 197 BOMBARDED BY 62 MEV. PROTONS.

15 DEG - RUN 126			30 DEG - RUN 131			50 DEG - RUN 137			75 DEG - RUN 142			95 DEG - RUN 132		
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR
3.95	1.733	0.165	3.84	0.081	0.011	3.84	0.105	0.012	3.83	0.049	0.009	3.89	0.068	0.007
4.35	1.628	0.161	4.24	0.174	0.016	4.24	0.103	0.012	4.23	0.085	0.011	4.29	0.053	0.007
4.75	1.586	0.159	4.64	0.187	0.017	4.64	0.087	0.011	4.63	0.071	0.010	4.69	0.060	0.007
5.46	2.250	0.123	5.34	0.223	0.012	5.34	0.124	0.008	5.33	0.087	0.007	5.39	0.063	0.004
6.46	3.868	0.157	6.35	0.345	0.015	6.35	0.201	0.010	6.33	0.115	0.008	6.39	0.099	0.006
7.47	3.473	0.149	7.35	0.396	0.016	7.35	0.299	0.012	7.34	0.205	0.011	7.40	0.189	0.008
8.48	3.727	0.154	8.35	0.655	0.020	8.36	0.530	0.017	8.34	0.374	0.015	8.40	0.386	0.011
9.48	3.219	0.143	9.36	0.831	0.023	9.36	0.695	0.019	9.34	0.506	0.018	9.40	0.479	0.012
10.49	3.166	0.142	10.36	1.209	0.027	10.36	1.073	0.024	10.34	0.941	0.024	10.41	0.854	0.017
11.50	3.263	0.144	11.37	1.405	0.029	11.37	1.204	0.025	11.34	1.041	0.025	11.41	0.885	0.017
12.50	3.346	0.146	12.37	1.504	0.031	12.37	1.335	0.026	12.34	1.090	0.026	12.41	0.883	0.017
13.51	3.613	0.152	13.37	1.696	0.032	13.37	1.417	0.027	13.34	1.097	0.026	13.42	0.893	0.017
14.51	4.023	0.160	14.38	1.837	0.034	14.38	1.562	0.028	14.35	1.118	0.026	14.42	0.934	0.017
15.52	4.565	0.171	15.38	1.909	0.034	15.38	1.628	0.029	15.35	1.156	0.027	15.42	0.863	0.017
16.53	4.573	0.171	16.38	1.979	0.035	16.39	1.698	0.030	16.35	1.155	0.027	16.42	0.854	0.017
17.53	4.525	0.170	17.39	2.069	0.035	17.39	1.764	0.030	17.35	1.174	0.027	17.43	0.850	0.017
18.54	4.782	0.174	18.39	2.067	0.035	18.39	1.795	0.031	18.35	1.125	0.026	18.43	0.807	0.016
19.55	5.181	0.182	19.39	2.029	0.035	19.40	1.827	0.031	19.35	1.077	0.026	19.43	0.788	0.016
20.55	5.266	0.183	20.40	1.974	0.035	20.40	1.914	0.032	20.35	0.986	0.025	20.44	0.728	0.015
21.56	5.272	0.183	21.40	2.023	0.200	21.40	1.883	0.031	21.35	0.970	0.027	21.44	0.708	0.015
22.56	5.279	0.183	22.40	2.085	0.200	22.41	1.887	0.031	22.36	0.953	0.025	22.44	0.661	0.015
23.57	5.619	0.189	23.41	2.147	0.220	23.41	1.921	0.032	23.36	0.938	0.024	23.45	0.635	0.014
24.58	5.625	0.189	24.41	2.205	0.220	24.42	1.881	0.031	24.36	0.922	0.022	24.45	0.607	0.014
25.58	5.846	0.193	25.42	2.261	0.230	25.42	2.039	0.033	25.36	0.908	0.021	25.45	0.581	0.014
26.59	6.169	0.198	26.42	2.319	0.230	26.42	1.974	0.032	26.36	0.892	0.020	26.45	0.556	0.013
27.50	6.236	0.199	27.42	2.378	0.240	27.43	1.959	0.032	27.36	0.877	0.020	27.46	0.535	0.013
28.60	6.234	0.199	28.43	2.442	0.240	28.43	1.866	0.032	28.36	0.861	0.020	28.46	0.500	0.013
29.61	6.411	0.202	29.43	2.495	0.250	29.43	1.966	0.032	29.37	0.845	0.020	29.46	0.464	0.012
30.61	5.998	0.195	30.43	2.555	0.260	30.44	1.934	0.032	30.37	0.829	0.020	30.47	0.414	0.012
31.62	6.678	0.206	31.44	2.615	0.260	31.44	1.953	0.032	31.37	0.813	0.020	31.47	0.411	0.011
32.63	5.992	0.195	32.44	2.267	0.230	32.45	1.912	0.032	32.37	0.799	0.022	32.47	0.376	0.011
33.63	6.657	0.206	33.44	2.729	0.041	33.45	1.952	0.032	33.37	0.828	0.022	33.48	0.351	0.011
34.64	6.595	0.205	34.45	2.752	0.041	34.45	1.885	0.031	34.37	0.772	0.022	34.48	0.343	0.010
35.64	6.763	0.208	35.45	2.845	0.042	35.46	1.863	0.031	35.37	0.765	0.022	35.48	0.314	0.010
36.65	6.037	0.196	36.45	2.673	0.040	36.46	1.804	0.031	36.38	0.705	0.021	36.48	0.278	0.009
37.66	6.546	0.204	37.46	2.813	0.041	37.46	1.765	0.030	37.38	0.647	0.020	37.49	0.260	0.009
38.66	7.222	0.214	38.46	2.799	0.041	38.47	1.762	0.030	38.38	0.638	0.020	38.49	0.236	0.009
39.67	6.999	0.211	39.46	2.722	0.041	39.47	1.821	0.031	39.38	0.619	0.019	39.49	0.202	0.008
40.68	7.692	0.221	40.47	2.726	0.041	40.48	1.755	0.030	40.38	0.549	0.018	40.50	0.187	0.008
41.68	7.576	0.220	41.47	2.660	0.040	41.48	1.653	0.029	41.38	0.496	0.017	41.50	0.157	0.008
42.69	7.372	0.217	42.48	2.677	0.040	42.49	1.602	0.029	42.38	0.468	0.017	42.50	0.168	0.007
43.69	7.272	0.215	43.48	2.712	0.041	43.49	1.558	0.028	43.39	0.449	0.017	43.51	0.152	0.007
44.70	6.863	0.209	44.48	2.621	0.040	44.49	1.529	0.028	44.39	0.461	0.017	44.51	0.132	0.007
45.71	7.376	0.217	45.49	2.636	0.040	45.49	1.526	0.028	45.39	0.412	0.016	45.51	0.116	0.006
46.71	7.235	0.215	46.49	2.760	0.041	46.50	1.566	0.029	46.39	0.401	0.016	46.52	0.117	0.006
47.72	7.194	0.214	47.49	2.800	0.041	47.50	1.450	0.027	47.39	0.379	0.015	47.52	0.097	0.006
48.73	7.077	0.212	48.50	2.706	0.041	48.51	1.411	0.027	48.39	0.313	0.014	48.52	0.099	0.006
49.73	7.076	0.212	49.50	2.769	0.041	49.51	1.312	0.026	49.39	0.309	0.014	49.52	0.089	0.005
50.74	6.482	0.203	50.50	2.669	0.040	50.51	1.231	0.025	50.40	0.244	0.012	50.53	0.076	0.005
51.74	7.336	0.216	51.51	2.418	0.038	51.52	1.142	0.024	51.40	0.251	0.012	51.53	0.063	0.004
52.75	7.766	0.222	52.51	2.250	0.037	52.52	1.055	0.023	52.40	0.216	0.011	52.53	0.060	0.004
53.76	8.000	1.600	53.51	2.280	0.037	53.52	1.077	0.024	53.40	0.219	0.012	53.54	0.053	0.004
54.76	8.000	1.600	54.52	2.238	0.037	54.53	1.076	0.024	54.40	0.202	0.011	54.54	0.053	0.004
55.77	8.000	1.600	55.52	2.367	0.038	55.53	1.040	0.023	55.40	0.180	0.010	55.54	0.050	0.004
56.77	8.000	1.600	56.53	2.708	0.041	56.54	1.033	0.023	56.40	0.162	0.010	56.55	0.039	0.004
57.78	8.000	1.600	57.53	2.410	0.038	57.54	0.822	0.021	57.41	0.131	0.009	57.55	0.040	0.004
58.79	8.000	1.600	58.53	2.089	0.036	58.54	0.915	0.022	58.41	0.108	0.008	58.55	0.039	0.004
59.79	8.000	1.600	59.54	1.521	0.030	59.55	0.501	0.016	59.41	0.104	0.008	59.55	0.011	0.003
60.80	3.500	0.700	60.51	3.363	0.046	60.52	0.692	0.021	60.36	0.639	0.021	60.53	0.066	0.008
61.65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 9 (cont.). PROTON FROM A = 197 BOMBARDED BY 62 MEV. PROTONS.

124 DEG - RUK 136

ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR C	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR C	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR C	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR C
3.84	0.062	C.011									
4.24	0.051	C.010									
4.64	0.036	C.009									
5.34	0.068	C.007									
6.34	0.100	C.009									
7.34	0.204	C.012									
8.35	0.373	C.016									
9.35	0.464	C.018									
10.35	0.790	C.024									
11.35	0.762	C.024									
12.36	0.736	C.023									
13.36	0.724	C.023									
14.36	0.673	C.022									
15.37	0.622	C.021									
16.37	0.610	C.021									
17.37	0.576	C.021									
18.37	0.546	C.020									
19.38	0.483	C.019									
20.38	0.465	C.018									
21.38	0.381	C.017									
22.38	0.241	C.016									
23.39	0.31	C.03									
24.39	0.30	C.03									
25.39	0.29	C.03									
26.39	0.27	C.03									
27.40	0.26	C.03									
28.40	0.241	C.024									
29.40	0.225	C.023									
30.41	0.210	C.021									
31.41	0.195	C.020									
32.41	0.180	C.019									
33.41	0.165	C.011									
34.42	0.152	C.011									
35.42	0.147	C.010									
36.42	0.109	C.009									
37.42	0.109	C.009									
38.43	0.178	C.009									
39.43	0.086	C.009									
40.43	0.073	C.007									
41.43	0.077	C.007									
42.44	0.057	C.006									
43.44	0.053	C.006									
44.44	0.046	C.006									
45.44	0.040	C.005									
46.45	0.036	C.005									
47.45	0.023	C.004									
48.45	0.023	C.004									
49.46	0.019	C.004									
50.46	0.021	C.004									
51.46	0.017	C.004									
52.46	0.013	C.003									
53.47	0.014	C.003									
54.47	0.011	C.003									
55.47	0.008	C.002									
56.47	0.008	C.002									
57.48	0.012	C.003									
58.48	0.006	C.002									
59.48	0.003	C.001									
60.48	0.012	C.007									

TABLE 10. DEUTERON FROM A = 197 BOMBARDED BY 52 MEV. PROTONS.

15 DEG - RUN 126			30 DEG - RUN 131			50 DEG - RUN 137			75 DEG - RUN 142			99 DEG - RUN 132		
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR
5.41	0.027	0.015	5.34	0.021	0.004	5.29	0.013	0.003	5.33	0.005	0.002	5.34	0.005	0.001
6.41	0.031	0.014	6.35	0.014	0.003	6.30	0.009	0.002	6.33	0.007	0.002	6.34	0.006	0.001
7.42	0.078	0.022	7.35	0.021	0.004	7.30	0.023	0.003	7.34	0.015	0.003	7.35	0.012	0.002
8.43	0.069	0.021	8.35	0.039	0.005	8.31	0.039	0.004	8.34	0.025	0.004	8.35	0.027	0.003
9.43	0.175	0.033	9.36	0.085	0.007	9.31	0.073	0.006	9.34	0.067	0.006	9.35	0.043	0.004
10.44	0.164	0.032	10.36	0.133	0.009	10.31	0.097	0.007	10.34	0.092	0.007	10.36	0.062	0.004
11.45	0.259	0.041	11.37	0.192	0.011	11.32	0.149	0.009	11.34	0.133	0.009	11.36	0.103	0.006
12.45	0.449	0.053	12.37	0.259	0.013	12.32	0.172	0.009	12.34	0.118	0.008	12.36	0.069	0.005
13.46	0.346	0.047	13.37	0.276	0.013	13.32	0.218	0.011	13.34	0.145	0.009	13.37	0.109	0.006
14.46	0.389	0.050	14.38	0.334	0.014	14.33	0.235	0.011	14.35	0.165	0.010	14.37	0.110	0.006
15.47	0.433	0.052	15.39	0.353	0.015	15.33	0.247	0.011	15.35	0.179	0.010	15.37	0.109	0.006
16.48	0.446	0.053	16.38	0.342	0.014	16.34	0.243	0.011	16.35	0.183	0.011	16.37	0.114	0.006
17.48	0.479	0.055	17.39	0.360	0.015	17.34	0.255	0.012	17.35	0.169	0.010	17.38	0.105	0.006
18.49	0.402	0.051	18.39	0.390	0.015	18.34	0.298	0.012	18.35	0.171	0.010	18.38	0.104	0.006
19.50	0.545	0.059	19.39	0.412	0.016	19.35	0.296	0.012	19.35	0.179	0.010	19.38	0.099	0.006
20.50	0.461	0.054	20.40	0.389	0.015	20.35	0.258	0.012	20.35	0.172	0.010	20.39	0.103	0.006
21.51	0.533	0.058	21.40	0.404	0.016	21.35	0.273	0.012	21.35	0.157	0.010	21.39	0.091	0.005
22.51	0.540	0.064	22.40	0.430	0.016	22.36	0.300	0.012	22.36	0.162	0.010	22.39	0.093	0.005
23.52	0.554	0.060	23.41	0.391	0.015	23.36	0.278	0.012	23.36	0.127	0.009	23.40	0.089	0.005
24.53	0.535	0.058	24.41	0.409	0.016	24.37	0.304	0.013	24.36	0.170	0.010	24.40	0.091	0.005
25.53	0.429	0.052	25.42	0.413	0.016	25.37	0.302	0.013	25.36	0.138	0.009	25.40	0.069	0.005
26.54	0.595	0.062	26.42	0.437	0.016	26.37	0.253	0.011	26.36	0.143	0.009	26.40	0.072	0.005
27.54	0.533	0.058	27.42	0.444	0.016	27.38	0.253	0.012	27.36	0.126	0.009	27.41	0.065	0.005
28.55	0.647	0.064	28.43	0.417	0.016	28.38	0.275	0.012	28.36	0.111	0.008	28.41	0.058	0.004
29.56	0.483	0.055	29.43	0.436	0.016	29.39	0.257	0.012	29.37	0.122	0.009	29.41	0.054	0.004
30.56	0.520	0.058	30.43	0.420	0.016	30.39	0.241	0.011	30.37	0.114	0.008	30.42	0.050	0.004
31.57	0.500	0.062	31.44	0.400	0.016	31.39	0.227	0.011	31.37	0.105	0.008	31.42	0.048	0.004
32.58	0.618	0.063	32.44	0.399	0.016	32.40	0.237	0.011	32.37	0.103	0.008	32.42	0.039	0.004
33.58	0.617	0.063	33.44	0.405	0.016	33.40	0.232	0.011	33.37	0.084	0.007	33.43	0.040	0.004
34.59	0.691	0.066	34.45	0.429	0.016	34.40	0.212	0.010	34.37	0.085	0.007	34.43	0.034	0.003
35.59	0.565	0.060	35.45	0.430	0.016	35.41	0.229	0.011	35.37	0.096	0.008	35.43	0.025	0.003
36.60	0.521	0.058	36.45	0.392	0.015	36.41	0.220	0.011	36.38	0.085	0.007	36.43	0.028	0.003
37.61	0.654	0.065	37.46	0.389	0.015	37.41	0.231	0.010	37.38	0.074	0.007	37.44	0.022	0.003
38.61	0.573	0.060	38.46	0.379	0.015	38.42	0.211	0.010	38.38	0.070	0.007	38.44	0.022	0.003
39.62	0.679	0.066	39.46	0.371	0.015	39.42	0.232	0.010	39.38	0.057	0.006	39.44	0.024	0.003
40.63	0.828	0.073	40.47	0.410	0.016	40.43	0.211	0.010	40.38	0.065	0.006	40.45	0.022	0.003
41.63	0.720	0.068	41.47	0.380	0.015	41.43	0.178	0.010	41.38	0.051	0.006	41.45	0.020	0.003
42.64	0.898	0.076	42.48	0.394	0.015	42.43	0.158	0.009	42.38	0.054	0.006	42.45	0.015	0.002
43.64	0.992	0.079	43.48	0.398	0.015	43.44	0.153	0.009	43.39	0.045	0.005	43.46	0.013	0.002
44.65	1.085	0.083	44.48	0.392	0.015	44.44	0.173	0.009	44.39	0.052	0.006	44.46	0.016	0.002
45.66	1.028	0.081	45.49	0.421	0.016	45.44	0.150	0.009	45.39	0.049	0.005	45.46	0.014	0.002
46.66	1.154	0.086	46.49	0.386	0.015	46.45	0.159	0.009	46.39	0.045	0.005	46.46	0.009	0.002
47.67	1.283	0.090	47.49	0.453	0.017	47.45	0.172	0.009	47.39	0.040	0.005	47.47	0.011	0.002
48.67	1.395	0.094	48.50	0.428	0.016	48.46	0.171	0.009	48.39	0.041	0.005	48.47	0.008	0.002
49.68	1.745	0.105	49.50	0.463	0.017	49.46	0.178	0.010	49.39	0.033	0.004	49.47	0.009	0.002
50.69	1.909	0.110	50.50	0.464	0.017	50.46	0.153	0.009	50.40	0.029	0.004	50.48	0.012	0.002
51.69	2.746	0.132	51.51	0.452	0.017	51.47	0.112	0.008	51.40	0.028	0.004	51.48	0.009	0.002
52.70	2.629	0.129	52.51	0.496	0.017	52.47	0.145	0.009	52.40	0.035	0.005	52.48	0.011	0.002
53.71	2.979	0.138	53.51	0.882	0.023	53.47	0.239	0.011	53.40	0.055	0.006	53.49	0.013	0.002
54.71	3.300	0.145	54.52	1.460	0.030	54.48	0.348	0.013	54.40	0.059	0.006	54.49	0.016	0.002
55.62	2.027	0.127	55.52	0.973	0.024	55.48	0.157	0.009	55.40	0.002	0.001	55.34	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55.93	0.0	0.0	0.0	0.0	0.0

TABLE 10 (cont.). DEUTERON FROM A = 197 BOMBARDED BY 62 MEV. PROTONS.

124 DEG - RUN 136

ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR
5.29	0.002	0.001									
6.29	0.003	0.002									
7.29	0.008	0.002									
8.30	0.021	0.004									
9.30	0.042	0.006									
10.30	0.060	0.007									
11.30	0.068	0.007									
12.31	0.061	0.007									
13.31	0.077	0.007									
14.31	0.077	0.007									
15.32	0.072	0.007									
16.32	0.068	0.007									
17.32	0.074	0.007									
18.32	0.061	0.007									
19.33	0.054	0.006									
20.33	0.065	0.007									
21.33	0.063	0.007									
22.33	0.047	0.006									
23.34	0.052	0.006									
24.34	0.033	0.005									
25.34	0.027	0.004									
26.34	0.031	0.005									
27.35	0.028	0.005									
28.35	0.027	0.004									
29.35	0.019	0.004									
30.35	0.023	0.004									
31.36	0.020	0.004									
32.36	0.013	0.003									
33.36	0.020	0.004									
34.37	0.014	0.003									
35.37	0.013	0.003									
36.37	0.014	0.003									
37.37	0.014	0.003									
38.38	0.009	0.003									
39.38	0.013	0.003									
40.38	0.008	0.002									
41.38	0.007	0.002									
42.39	0.007	0.002									
43.39	0.006	0.002									
44.39	0.004	0.002									
45.39	0.004	0.002									
46.40	0.003	0.002									
47.40	0.007	0.002									
48.40	0.001	0.001									
49.41	0.003	0.001									
50.41	0.003	0.002									
51.41	0.002	0.001									
52.41	0.003	0.002									
53.42	0.006	0.002									
54.42	0.002	0.001									
55.15	0.0	0.0									

15 DEG - RUN 126			30 DEG - RUN 131			50 DEG - RUN 137			75 DEG - RUN 142			99 DEG - RUN 132		
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR
6.97	0.00	0.00	6.95	0.006	0.002	6.95	0.006	0.002	6.83	0.004	0.002	6.85	0.002	0.001
7.97	0.025	0.013	7.85	0.006	0.002	7.95	0.007	0.002	7.84	0.005	0.002	7.85	0.004	0.001
8.98	0.034	0.015	8.86	0.024	0.004	8.96	0.023	0.003	8.84	0.013	0.003	8.85	0.015	0.002
9.99	0.050	0.018	9.86	0.047	0.005	9.86	0.046	0.005	9.84	0.031	0.004	9.85	0.033	0.003
10.99	0.069	0.021	10.86	0.068	0.006	10.87	0.065	0.006	10.84	0.036	0.005	10.86	0.037	0.003
12.00	0.053	0.018	11.87	0.086	0.007	11.87	0.075	0.006	11.84	0.060	0.006	11.86	0.048	0.004
13.01	0.116	0.027	12.87	0.093	0.008	12.87	0.079	0.006	12.84	0.071	0.007	12.86	0.048	0.004
14.01	0.057	0.019	13.87	0.044	0.005	13.88	0.053	0.005	13.84	0.074	0.007	13.87	0.046	0.004
15.02	0.169	0.033	14.88	0.148	0.009	14.88	0.115	0.008	14.95	0.036	0.005	14.87	0.042	0.004
16.02	0.186	0.034	15.88	0.167	0.010	15.88	0.125	0.008	15.85	0.077	0.007	15.87	0.040	0.004
17.03	0.235	0.039	16.88	0.156	0.010	16.89	0.124	0.008	16.85	0.080	0.007	16.88	0.048	0.004
18.04	0.192	0.035	17.89	0.186	0.011	17.89	0.135	0.008	17.85	0.074	0.007	17.88	0.043	0.004
19.04	0.176	0.033	18.89	0.163	0.010	18.90	0.120	0.008	18.85	0.066	0.006	18.88	0.038	0.004
20.05	0.185	0.034	19.90	0.188	0.011	19.90	0.119	0.008	19.85	0.068	0.006	19.88	0.035	0.003
21.05	0.257	0.040	20.90	0.157	0.010	20.90	0.115	0.008	20.85	0.073	0.007	20.89	0.028	0.003
22.06	0.212	0.037	21.90	0.161	0.010	21.91	0.096	0.007	21.86	0.059	0.006	21.89	0.030	0.003
23.07	0.166	0.032	22.91	0.150	0.010	22.91	0.176	0.007	22.86	0.055	0.006	22.89	0.028	0.003
24.07	0.173	0.033	23.91	0.136	0.009	23.91	0.101	0.007	23.86	0.044	0.005	23.90	0.021	0.003
25.08	0.227	0.038	24.91	0.167	0.010	24.92	0.101	0.007	24.86	0.054	0.006	24.90	0.020	0.003
26.09	0.176	0.034	25.92	0.144	0.009	25.92	0.085	0.007	25.86	0.038	0.005	25.90	0.020	0.003
27.09	0.200	0.036	26.92	0.147	0.009	26.93	0.084	0.007	26.86	0.039	0.005	26.91	0.018	0.002
28.10	0.191	0.035	27.92	0.135	0.009	27.93	0.083	0.007	27.86	0.030	0.004	27.91	0.016	0.002
29.10	0.189	0.035	28.93	0.138	0.009	28.93	0.076	0.006	28.87	0.032	0.004	28.91	0.008	0.002
30.11	0.140	0.030	29.93	0.129	0.009	29.94	0.085	0.007	29.87	0.031	0.004	29.92	0.015	0.002
31.12	0.207	0.036	30.93	0.119	0.009	30.94	0.074	0.006	30.87	0.034	0.005	30.92	0.013	0.002
32.12	0.149	0.031	31.94	0.121	0.009	31.94	0.061	0.006	31.87	0.030	0.004	31.92	0.012	0.002
33.13	0.232	0.038	32.94	0.112	0.008	32.95	0.067	0.006	32.87	0.023	0.004	32.92	0.009	0.002
34.14	0.113	0.027	33.95	0.102	0.008	33.95	0.060	0.006	33.87	0.023	0.004	33.92	0.005	0.001
35.14	0.194	0.035	34.95	0.109	0.008	34.96	0.045	0.005	34.87	0.018	0.003	34.92	0.012	0.002
36.15	0.166	0.032	35.95	0.104	0.008	35.96	0.052	0.005	35.88	0.018	0.003	35.93	0.008	0.002
37.15	0.171	0.033	36.96	0.123	0.009	36.96	0.050	0.005	36.88	0.021	0.004	36.94	0.004	0.001
38.16	0.117	0.027	37.96	0.091	0.007	37.97	0.050	0.005	37.88	0.010	0.002	37.94	0.005	0.001
39.17	0.184	0.034	38.96	0.102	0.008	38.97	0.042	0.005	38.88	0.015	0.003	38.94	0.006	0.001
40.17	0.158	0.032	39.97	0.096	0.008	39.97	0.047	0.005	39.88	0.011	0.003	39.95	0.005	0.001
41.18	0.165	0.032	40.97	0.081	0.007	40.99	0.034	0.004	40.88	0.013	0.003	40.95	0.002	0.001
42.18	0.159	0.032	41.97	0.092	0.008	41.98	0.032	0.004	41.88	0.010	0.002	41.95	0.004	0.001
43.19	0.168	0.033	42.98	0.082	0.007	42.99	0.032	0.004	42.88	0.009	0.002	42.95	0.004	0.001
44.20	0.191	0.035	43.98	0.085	0.007	43.99	0.026	0.004	43.89	0.011	0.003	43.96	0.002	0.001
45.20	0.143	0.030	44.98	0.086	0.007	44.99	0.027	0.004	44.89	0.010	0.003	44.96	0.001	0.001
46.21	0.095	0.025	45.99	0.088	0.007	46.00	0.035	0.004	45.89	0.010	0.002	45.96	0.003	0.001
47.22	0.102	0.025	46.99	0.079	0.007	47.00	0.022	0.003	46.89	0.007	0.002	46.97	0.001	0.001
48.22	0.136	0.029	48.00	0.067	0.006	48.00	0.020	0.003	47.89	0.003	0.001	47.97	0.001	0.001
49.23	0.082	0.023	49.00	0.045	0.005	49.01	0.010	0.002	48.89	0.005	0.002	48.97	0.001	0.001
50.23	0.082	0.023	50.00	0.043	0.005	50.01	0.011	0.002	49.89	0.003	0.001	49.98	0.001	0.001
51.24	0.074	0.022	51.01	0.053	0.006	51.02	0.014	0.003	50.90	0.005	0.002	50.98	0.001	0.001
52.25	0.032	0.014	52.01	0.036	0.005	52.02	0.010	0.002	51.90	0.003	0.001	51.98	0.001	0.000
53.25	0.023	0.012	53.01	0.024	0.004	53.02	0.003	0.001	52.90	0.000	0.000	52.98	0.000	0.000
54.26	0.006	0.006	54.02	0.001	0.001	54.03	0.000	0.001	53.90	0.000	0.000	53.99	0.000	0.000
55.27	0.000	0.000	55.02	0.005	0.002	55.03	0.000	0.001	54.85	0.000	0.001	54.74	0.000	0.000
56.27	0.000	0.000	55.77	0.000	0.000	55.68	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
57.28	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
58.28	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
59.29	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60.30	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
61.30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
61.91	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 11 (cont.) TRITON FROM A = 197 BOMBARDED BY 62 MEV. PROTONS.

124 DFG - RUN 136

ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR
6.84	0.003	0.001									
7.85	0.007	0.002									
8.85	0.010	0.003									
9.85	0.022	0.004									
10.85	0.032	0.005									
11.86	0.035	0.005									
12.86	0.032	0.005									
13.86	0.028	0.005									
14.86	0.026	0.004									
15.87	0.020	0.004									
16.87	0.024	0.004									
17.87	0.021	0.004									
18.87	0.019	0.004									
19.88	0.016	0.003									
20.88	0.018	0.004									
21.88	0.020	0.004									
22.89	0.011	0.003									
23.89	0.015	0.003									
24.89	0.010	0.003									
25.89	0.012	0.003									
26.90	0.007	0.002									
27.90	0.010	0.003									
28.90	0.006	0.002									
29.90	0.007	0.002									
30.91	0.005	0.002									
31.91	0.001	0.001									
32.91	0.004	0.002									
33.91	0.002	0.001									
34.92	0.002	0.001									
35.92	0.001	0.001									
36.92	0.002	0.001									
37.92	0.002	0.001									
38.93	0.004	0.002									
39.93	0.001	0.001									
40.93	0.001	0.001									
41.94	0.001	0.001									
42.94	0.0	0.0									
43.94	0.0	0.0									
44.94	0.001	0.001									
45.95	0.001	0.001									
46.95	0.001	0.001									
47.95	0.001	0.001									
48.95	0.0	0.0									
49.96	0.0	0.0									
50.96	0.0	0.0									
51.96	0.0	0.0									
52.96	0.0	0.0									
53.97	0.0	0.0									
54.52	0.0	0.0									

TABLE 12. HELIUM-3 FROM A = 197 BOMBARDED BY 62 MEV. PROTONS.

15 DEG - RUN 126			30 DEG - RUN 131			50 DEG - RUN 137			75 DEG - RUN 142			99 DEG - RUN 132		
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR
13.11	0.006	0.006	13.02	0.002	0.001	12.97	0.002	0.001	12.99	0.001	0.001	13.06	0.0	0.0
14.11	0.0	0.0	14.02	0.001	0.001	13.98	0.001	0.001	13.99	0.0	0.0	14.07	0.000	0.000
15.12	0.004	0.005	15.03	0.002	0.001	14.99	0.000	0.000	15.00	0.001	0.001	15.07	0.000	0.000
16.12	0.009	0.007	16.03	0.001	0.001	15.98	0.001	0.001	16.00	0.0	0.0	16.07	0.000	0.000
17.13	0.0	0.0	17.04	0.003	0.001	16.99	0.004	0.001	17.00	0.001	0.001	17.08	0.001	0.001
18.14	0.0	0.0	18.04	0.002	0.001	17.99	0.002	0.001	18.00	0.0	0.0	18.08	0.000	0.000
19.14	0.0	0.0	19.04	0.002	0.001	19.00	0.001	0.001	19.00	0.001	0.001	19.08	0.0	0.0
20.15	0.0	0.0	20.05	0.003	0.001	20.00	0.004	0.001	20.00	0.002	0.001	20.09	0.001	0.001
21.16	0.006	0.006	21.05	0.003	0.001	21.00	0.003	0.001	21.00	0.001	0.001	21.09	0.001	0.001
22.16	0.0	0.0	22.05	0.004	0.002	22.01	0.005	0.002	22.01	0.004	0.002	22.09	0.002	0.001
23.17	0.006	0.006	23.06	0.005	0.002	23.01	0.007	0.002	23.01	0.004	0.001	23.09	0.003	0.001
24.17	0.013	0.009	24.06	0.005	0.002	24.01	0.004	0.001	24.01	0.005	0.002	24.10	0.002	0.001
25.18	0.019	0.011	25.06	0.006	0.002	25.02	0.006	0.002	25.01	0.005	0.002	25.10	0.002	0.001
26.19	0.013	0.009	26.07	0.011	0.003	26.02	0.008	0.002	26.01	0.003	0.001	26.10	0.002	0.001
27.19	0.025	0.013	27.07	0.015	0.003	27.03	0.007	0.002	27.01	0.006	0.002	27.11	0.002	0.001
28.20	0.002	0.004	28.07	0.016	0.003	28.03	0.005	0.002	28.01	0.007	0.002	28.11	0.004	0.001
29.20	0.030	0.014	29.08	0.010	0.002	29.03	0.016	0.003	29.02	0.006	0.002	29.11	0.003	0.001
30.21	0.026	0.013	30.08	0.019	0.003	30.04	0.013	0.003	30.02	0.005	0.002	30.12	0.002	0.001
31.22	0.043	0.017	31.09	0.020	0.004	31.04	0.013	0.003	31.02	0.009	0.002	31.12	0.004	0.001
32.22	0.013	0.009	32.09	0.014	0.003	32.04	0.011	0.002	32.02	0.002	0.001	32.12	0.001	0.001
33.23	0.019	0.011	33.09	0.014	0.003	33.05	0.012	0.002	33.02	0.005	0.002	33.12	0.001	0.001
34.24	0.038	0.016	34.10	0.019	0.003	34.05	0.016	0.003	34.02	0.003	0.001	34.13	0.002	0.001
35.24	0.015	0.010	35.10	0.023	0.004	35.06	0.012	0.002	35.02	0.003	0.001	35.13	0.003	0.001
36.25	0.032	0.014	36.10	0.014	0.003	36.06	0.011	0.002	36.03	0.001	0.001	36.13	0.002	0.001
37.25	0.054	0.019	37.11	0.022	0.004	37.06	0.009	0.002	37.03	0.006	0.002	37.14	0.002	0.001
38.26	0.051	0.018	38.11	0.017	0.003	38.07	0.013	0.003	38.03	0.006	0.002	38.14	0.001	0.001
39.27	0.039	0.016	39.11	0.013	0.003	39.07	0.006	0.002	39.03	0.003	0.001	39.14	0.002	0.001
40.27	0.032	0.014	40.12	0.025	0.004	40.07	0.011	0.002	40.03	0.001	0.001	40.15	0.001	0.001
41.28	0.025	0.013	41.12	0.015	0.003	41.08	0.012	0.003	41.03	0.003	0.001	41.15	0.002	0.001
42.29	0.045	0.017	42.12	0.017	0.003	42.08	0.012	0.002	42.03	0.002	0.001	42.15	0.000	0.000
43.29	0.041	0.016	43.13	0.019	0.003	43.09	0.017	0.002	43.04	0.004	0.002	43.15	0.001	0.001
44.30	0.033	0.015	44.13	0.019	0.003	44.09	0.006	0.002	44.04	0.006	0.002	44.16	0.002	0.001
45.30	0.071	0.021	45.14	0.022	0.004	45.09	0.011	0.002	45.04	0.002	0.001	45.16	0.001	0.001
46.31	0.036	0.015	46.14	0.019	0.003	46.10	0.010	0.002	46.04	0.004	0.002	46.16	0.001	0.001
47.32	0.043	0.017	47.14	0.018	0.003	47.10	0.006	0.002	47.04	0.002	0.001	47.17	0.0	0.0
48.32	0.049	0.018	48.15	0.018	0.003	48.10	0.007	0.002	48.04	0.002	0.001	48.17	0.001	0.000
49.33	0.044	0.017	49.15	0.020	0.003	49.11	0.007	0.002	49.04	0.002	0.001	49.17	0.0	0.0
50.34	0.037	0.015	50.15	0.038	0.005	50.11	0.008	0.002	50.04	0.001	0.001	50.18	0.001	0.000
51.34	0.014	0.009	51.16	0.034	0.005	51.12	0.008	0.002	51.05	0.002	0.001	51.18	0.001	0.001
52.35	0.056	0.019	52.16	0.034	0.005	52.12	0.007	0.002	52.05	0.002	0.001	52.18	0.000	0.000
53.35	0.0	0.0	53.16	0.017	0.003	53.12	0.002	0.001	53.05	0.0	0.0	53.19	0.0	0.0
54.36	0.0	0.0	54.17	0.006	0.002	54.13	0.001	0.001	54.05	0.0	0.0	54.19	0.0	0.0
55.37	0.0	0.0	55.17	0.001	0.001	55.13	0.0	0.0	55.05	0.0	0.0	55.99	0.0	0.0
56.37	0.0	0.0	55.85	0.0	0.0	55.81	0.0	0.0	55.59	0.0	0.0	0.0	0.0	0.0
57.38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
58.38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
59.39	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
61.40	0.006	0.006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
61.96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 12 (cont.). HELIUM-3 FROM A = 197 BOMBARDED BY 62 MEV. PROTONS.

124 DEG - RUN 136

ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR (MEV)	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR (MEV)	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR (MEV)	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR (MEV)
12.96	0.000	0.000									
13.96	0.002	0.001									
14.96	0.0	0.0									
15.97	0.0	0.0									
16.97	0.001	0.001									
17.97	0.001	0.001									
18.97	0.001	0.001									
19.98	0.000	0.000									
20.98	0.002	0.001									
21.98	0.001	0.001									
22.99	0.0	0.0									
23.99	0.0	0.0									
24.99	0.001	0.001									
25.99	0.001	0.001									
27.00	0.001	0.001									
28.00	0.001	0.001									
29.00	0.000	0.000									
30.00	0.001	0.001									
31.01	0.002	0.001									
32.01	0.001	0.001									
33.01	0.0	0.0									
34.01	0.001	0.001									
35.02	0.0	0.0									
36.02	0.0	0.0									
37.02	0.001	0.001									
38.03	0.0	0.0									
39.03	0.0	0.0									
40.03	0.0	0.0									
41.03	0.0	0.0									
42.04	0.0	0.0									
43.04	0.001	0.001									
44.04	0.0	0.0									
45.04	0.0	0.0									
46.05	0.001	0.001									
47.05	0.0	0.0									
48.05	0.0	0.0									
49.05	0.0	0.0									
50.06	0.0	0.0									
51.06	0.0	0.0									
52.06	0.001	0.001									
53.06	0.0	0.0									
54.07	0.0	0.0									
54.69	0.0	0.0									

TABLE 13. ALPHA FROM A = 197 BOMBARDED BY 62 MEV. PROTONS.

15 DEG - RUN 126			30 DEG - RUN 131			50 DEG - RUN 137			75 DEG - RUN 142			99 DEG - RUN 132		
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR
14.41	0.012	0.009	14.28	0.018	0.003	14.28	0.018	0.003	12.64	0.003	0.001	12.71	0.003	0.001
15.42	0.021	0.012	15.28	0.029	0.004	15.28	0.026	0.004	13.64	0.010	0.003	13.72	0.011	0.002
16.43	0.086	0.023	16.28	0.063	0.006	16.29	0.052	0.005	14.65	0.019	0.003	14.72	0.020	0.003
17.43	0.096	0.025	17.29	0.097	0.008	17.29	0.094	0.007	15.65	0.045	0.005	15.72	0.049	0.004
18.44	0.207	0.026	18.29	0.167	0.010	18.29	0.154	0.009	16.65	0.079	0.007	16.73	0.099	0.006
19.44	0.186	0.034	19.29	0.224	0.012	19.30	0.217	0.011	17.65	0.115	0.008	17.73	0.144	0.007
20.45	0.342	0.047	20.30	0.270	0.013	20.30	0.230	0.011	18.65	0.194	0.011	18.73	0.193	0.008
21.46	0.303	0.044	21.30	0.251	0.012	21.30	0.210	0.010	19.65	0.191	0.011	19.73	0.183	0.008
22.46	0.288	0.043	22.30	0.232	0.012	22.31	0.208	0.010	20.65	0.162	0.010	20.74	0.151	0.007
23.47	0.287	0.043	23.31	0.236	0.012	23.31	0.199	0.010	21.66	0.172	0.010	21.74	0.125	0.006
24.48	0.224	0.038	24.31	0.229	0.012	24.32	0.194	0.010	22.66	0.144	0.009	22.74	0.109	0.006
25.48	0.228	0.038	25.31	0.259	0.013	25.32	0.197	0.010	23.66	0.118	0.008	23.75	0.079	0.005
26.49	0.335	0.046	26.32	0.224	0.012	26.32	0.155	0.009	24.66	0.116	0.008	24.75	0.084	0.005
27.49	0.180	0.034	27.32	0.226	0.012	27.33	0.152	0.009	25.66	0.101	0.008	25.75	0.062	0.004
28.50	0.218	0.037	28.33	0.208	0.011	28.33	0.154	0.009	26.66	0.092	0.008	26.76	0.055	0.004
29.51	0.183	0.034	29.33	0.211	0.011	29.33	0.123	0.008	27.66	0.087	0.007	27.76	0.040	0.004
30.51	0.172	0.033	30.33	0.195	0.011	30.34	0.129	0.008	28.67	0.073	0.007	28.76	0.047	0.004
31.52	0.237	0.039	31.34	0.175	0.010	31.34	0.114	0.008	29.67	0.083	0.007	29.76	0.040	0.004
32.53	0.130	0.029	32.34	0.153	0.010	32.35	0.107	0.007	30.67	0.070	0.007	30.77	0.035	0.003
33.53	0.114	0.027	33.34	0.149	0.010	33.35	0.096	0.007	31.67	0.066	0.006	31.77	0.035	0.003
34.54	0.210	0.037	34.35	0.109	0.008	34.35	0.074	0.006	32.67	0.051	0.006	32.77	0.031	0.003
35.54	0.135	0.029	35.35	0.101	0.008	35.36	0.057	0.005	33.67	0.050	0.006	33.78	0.026	0.003
36.55	0.072	0.021	36.35	0.049	0.005	36.36	0.024	0.004	34.67	0.052	0.006	34.78	0.031	0.003
37.56	0.237	0.039	37.36	0.130	0.009	37.36	0.059	0.006	35.67	0.042	0.005	35.78	0.016	0.002
38.56	0.128	0.029	38.36	0.145	0.009	38.37	0.068	0.006	36.68	0.011	0.003	36.79	0.008	0.002
39.57	0.094	0.024	39.36	0.123	0.009	39.37	0.052	0.006	37.68	0.015	0.003	37.79	0.015	0.002
40.58	0.180	0.034	40.37	0.108	0.008	40.38	0.070	0.006	38.68	0.013	0.003	38.79	0.012	0.002
41.58	0.106	0.026	41.37	0.086	0.007	41.38	0.051	0.005	39.68	0.020	0.003	39.79	0.010	0.002
42.59	0.158	0.032	42.38	0.091	0.007	42.39	0.048	0.005	40.68	0.018	0.003	40.80	0.011	0.002
43.59	0.088	0.024	43.38	0.098	0.008	43.39	0.050	0.005	41.68	0.019	0.003	41.80	0.008	0.002
44.60	0.113	0.027	44.38	0.083	0.007	44.39	0.042	0.005	42.68	0.017	0.003	42.80	0.008	0.002
45.61	0.131	0.029	45.39	0.072	0.007	45.39	0.039	0.005	43.69	0.011	0.003	43.81	0.006	0.001
46.61	0.041	0.016	46.39	0.061	0.006	46.40	0.027	0.004	44.69	0.019	0.003	44.81	0.003	0.001
47.62	0.112	0.027	47.39	0.064	0.006	47.40	0.023	0.003	45.69	0.010	0.002	45.81	0.003	0.001
48.62	0.079	0.022	48.40	0.049	0.005	48.41	0.023	0.003	46.69	0.012	0.003	46.82	0.004	0.001
49.63	0.049	0.018	49.40	0.050	0.005	49.41	0.032	0.004	47.69	0.007	0.002	47.82	0.002	0.001
50.64	0.070	0.021	50.40	0.053	0.006	50.41	0.020	0.003	48.69	0.007	0.002	48.82	0.003	0.001
51.64	0.093	0.024	51.41	0.055	0.006	51.42	0.018	0.003	49.69	0.007	0.002	49.83	0.003	0.001
52.65	0.065	0.020	52.41	0.034	0.005	52.42	0.019	0.003	50.70	0.007	0.002	50.83	0.001	0.001
53.66	0.058	0.019	53.41	0.037	0.005	53.42	0.017	0.003	51.70	0.005	0.002	51.83	0.002	0.001
54.66	0.031	0.014	54.42	0.043	0.005	54.43	0.016	0.003	52.70	0.003	0.001	52.83	0.001	0.001
55.67	0.025	0.013	55.42	0.034	0.005	55.43	0.010	0.002	53.70	0.004	0.002	53.84	0.002	0.001
56.67	0.038	0.016	56.43	0.037	0.005	56.44	0.009	0.002	54.70	0.003	0.001	54.84	0.001	0.000
57.68	0.019	0.011	57.43	0.030	0.004	57.44	0.007	0.002	55.70	0.004	0.002	55.84	0.001	0.000
58.69	0.039	0.016	58.43	0.024	0.004	58.44	0.010	0.002	56.70	0.001	0.001	56.85	0.000	0.000
59.69	0.006	0.006	59.44	0.021	0.004	59.45	0.005	0.002	57.71	0.001	0.001	57.85	0.001	0.000
60.70	0.013	0.009	60.44	0.016	0.003	60.45	0.004	0.001	58.71	0.004	0.002	58.85	0.000	0.000
61.60	0.024	0.014	61.44	0.011	0.003	61.45	0.003	0.001	59.71	0.004	0.001	59.86	0.000	0.000
0.0	0.0	0.0	61.97	0.015	0.013	61.98	0.0	0.0	60.71	0.003	0.001	60.86	0.000	0.000
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	61.61	0.0	0.0	61.69	0.0	0.0

TABLE 13 (cont.). ALPHA FROM A = 197 BOMBARDED BY 62 MEV. PROTONS.

124 DEG - RUN 136

ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR (MEV)	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR (MEV)	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR (MEV)	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR (MEV)
12.56	0.003	0.001									
13.56	0.008	0.002									
14.56	0.022	0.004									
15.57	0.062	0.007									
16.57	0.118	0.009									
17.57	0.146	0.010									
18.57	0.180	0.011									
19.58	0.157	0.011									
20.58	0.138	0.010									
21.58	0.088	0.008									
22.58	0.061	0.007									
23.59	0.061	0.007									
24.59	0.059	0.007									
25.59	0.032	0.005									
26.60	0.031	0.005									
27.60	0.027	0.004									
28.60	0.020	0.004									
29.60	0.020	0.004									
30.61	0.022	0.004									
31.61	0.015	0.003									
32.61	0.010	0.003									
33.61	0.009	0.003									
34.62	0.016	0.003									
35.62	0.015	0.003									
36.62	0.004	0.002									
37.62	0.006	0.002									
38.63	0.006	0.002									
39.63	0.005	0.002									
40.63	0.004	0.002									
41.63	0.002	0.001									
42.64	0.004	0.002									
43.64	0.004	0.002									
44.64	0.0	0.0									
45.65	0.001	0.001									
46.65	0.0	0.0									
47.65	0.001	0.001									
48.65	0.001	0.001									
49.66	0.0	0.0									
50.66	0.001	0.001									
51.66	0.0	0.0									
52.66	0.001	0.001									
53.67	0.0	0.0									
54.67	0.0	0.0									
55.67	0.001	0.001									
56.67	0.001	0.001									
57.68	0.0	0.0									
58.68	0.0	0.0									
59.68	0.0	0.0									
60.68	0.0	0.0									
61.59	0.0	0.0									

TABLE 14. PROTON FROM A = 197 BOMBARDED BY 29 MEV. PROTONS.

3° DEG - RUN 23			60 DEG - RUN 22			90 DEG - RUN 16			130 DEG - RUN 21			ENERGY (MEV)	SIGMA ERROR (MB/SR-MEV)	
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR			
3.85	0.796	0.121	3.79	0.057	0.012	3.89	0.237	0.007	4.19	0.227	0.018			
4.25	0.879	0.127	4.20	0.058	0.012	4.29	0.240	0.007	4.60	0.257	0.019			
4.66	0.887	0.128	4.60	0.086	0.015	4.69	0.224	0.005	5.30	0.224	0.011			
5.36	0.920	0.082	5.30	0.070	0.009	5.39	0.234	0.004	6.30	0.168	0.010			
6.37	1.099	0.090	6.31	0.121	0.011	6.40	0.047	0.005	7.31	0.205	0.011			
7.37	1.420	0.102	7.31	0.188	0.014	7.40	0.072	0.006	8.31	0.312	0.013			
8.38	1.716	0.112	8.32	0.298	0.018	8.41	0.196	0.009	9.32	0.363	0.014			
9.39	1.540	0.106	9.32	0.399	0.020	9.41	0.295	0.012	10.32	0.823	0.021			
10.39	2.451	0.134	10.33	0.965	0.032	10.41	0.659	0.017	11.32	0.674	0.019			
11.40	2.700	0.141	11.33	1.062	0.033	11.42	0.526	0.017	12.33	0.598	0.018			
12.41	2.655	0.140	12.34	1.071	0.033	12.42	0.601	0.016	13.33	0.563	0.018			
13.41	2.103	0.151	13.34	1.172	0.035	13.42	0.565	0.016	14.34	0.535	0.017			
14.42	2.781	0.143	14.35	1.195	0.035	14.43	0.585	0.016	15.34	0.519	0.017			
15.43	3.011	0.149	15.35	1.237	0.036	15.43	0.624	0.017	16.35	0.476	0.016			
16.43	3.478	0.160	16.36	1.331	0.037	16.43	0.592	0.016	17.35	0.443	0.016			
17.44	3.484	0.160	17.36	1.342	0.037	17.44	0.527	0.015	18.36	0.347	0.014			
18.45	3.195	0.153	18.36	1.240	0.036	18.44	0.477	0.015	19.36	0.318	0.013			
19.45	3.298	0.156	19.37	1.182	0.035	19.45	0.444	0.014	20.36	0.274	0.012			
20.46	3.012	0.149	20.37	1.138	0.034	20.45	0.444	0.014	21.37	0.285	0.013			
21.46	3.415	0.158	21.38	1.207	0.035	21.45	0.427	0.014	22.37	0.260	0.012			
22.47	3.423	0.158	22.38	1.162	0.035	22.46	0.428	0.014	23.38	0.201	0.011			
23.48	3.458	0.159	23.39	1.144	0.035	23.46	0.356	0.013	24.38	0.155	0.009			
24.48	3.155	0.152	24.39	1.029	0.033	24.46	0.332	0.012	25.39	0.139	0.009			
25.49	2.994	0.148	25.40	0.929	0.031	25.47	0.268	0.011	26.39	0.104	0.008			
26.50	3.684	0.164	26.40	0.922	0.031	26.47	0.188	0.009	27.40	0.095	0.007			
27.50	2.025	0.122	27.41	0.394	0.020	27.48	0.179	0.009	27.92	0.0	0.0			
28.16	11.349	0.527	28.06	1.811	0.079	28.03	0.323	0.038	0.0	0.0	0.0			

TABLE 15. DEUTERON FROM A = 197 BOMBARDED BY 29 MEV. PROTONS.

30 DEG - RUN 23			60 DEG - RUN 22			90 DEG - RUN 16			130 DEG - RUN 21			ENERGY		
ENERGY	SIGMA	ERROR	ENERGY	SIGMA	ERROR	ENERGY	SIGMA	ERROR	ENERGY	SIGMA	ERROR	ENERGY	SIGMA	ERROR
(MEV)	(MB/SR-MEV)		(MEV)	(MB/SR-MEV)		(MEV)	(MB/SR-MEV)		(MEV)	(MB/SR-MEV)		(MEV)	(MB/SR-MEV)	
5.31	0.0	0.0	5.25	0.004	0.002	5.34	0.006	0.002	5.70	0.006	0.002			
6.32	0.015	0.010	6.26	0.003	0.002	6.35	0.007	0.002	6.70	0.004	0.002			
7.32	0.022	0.013	7.26	0.010	0.003	7.35	0.007	0.002	7.71	0.007	0.002			
8.33	0.037	0.016	8.27	0.015	0.004	8.36	0.012	0.002	8.71	0.011	0.003			
9.34	0.060	0.021	9.27	0.037	0.006	9.36	0.029	0.004	9.72	0.016	0.003			
10.34	0.123	0.030	10.28	0.057	0.008	10.36	0.040	0.004	10.72	0.040	0.005			
11.35	0.160	0.034	11.28	0.116	0.011	11.37	0.050	0.005	11.73	0.047	0.005			
12.36	0.114	0.029	12.29	0.119	0.011	12.37	0.037	0.004	12.73	0.035	0.004			
13.36	0.344	0.050	13.29	0.164	0.013	13.37	0.075	0.006	13.74	0.062	0.006			
14.37	0.261	0.044	14.29	0.214	0.015	14.38	0.074	0.006	14.74	0.064	0.006			
15.38	0.437	0.057	15.30	0.237	0.016	15.38	0.092	0.006	15.74	0.053	0.005			
16.38	0.520	0.062	16.30	0.277	0.017	16.38	0.102	0.007	16.75	0.039	0.005			
17.39	0.594	0.066	17.31	0.255	0.016	17.39	0.105	0.007	17.75	0.046	0.005			
18.39	0.827	0.078	18.31	0.311	0.018	18.39	0.071	0.006	18.76	0.044	0.005			
19.40	0.822	0.078	19.32	0.274	0.017	19.40	0.084	0.006	19.76	0.041	0.005			
20.41	0.991	0.085	20.32	0.468	0.022	20.40	0.158	0.008	20.77	0.073	0.006			
21.41	3.340	0.157	21.33	1.204	0.035	21.40	0.254	0.011	21.77	0.120	0.008			
22.42	5.967	0.209	22.33	1.655	0.042	22.41	0.252	0.011	22.35	0.074	0.017			
23.00	0.247	0.110	22.91	0.032	0.015	22.96	0.0	0.0	0.0	0.0	0.0			

TABLE 16. TRITON FROM A = 197 BOMBARDED BY 29 MEV. PROTONS.

30 DEG - RUN 23			60 DEG - RUN 22			90 DEG - RUN 16			130 DEG - RUN 21					
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR
6.82	0.0	0.0	6.81	0.001	0.001	6.90	0.001	0.001	7.31	0.001	0.001			
7.83	0.0	0.0	7.81	0.001	0.001	7.90	0.001	0.001	8.31	0.001	0.001			
8.83	0.007	0.007	8.82	0.008	0.003	8.91	0.004	0.001	9.32	0.007	0.002			
9.84	0.031	0.015	9.82	0.013	0.004	9.91	0.036	0.002	10.32	0.011	0.002			
10.85	0.071	0.023	10.83	0.044	0.007	10.91	0.016	0.003	11.32	0.010	0.002			
11.85	0.107	0.028	11.83	0.049	0.007	11.92	0.027	0.003	12.33	0.015	0.003			
12.86	0.111	0.029	12.84	0.072	0.009	12.92	0.027	0.004	13.33	0.025	0.004			
13.87	0.171	0.035	13.84	0.067	0.008	13.93	0.033	0.004	14.34	0.015	0.003			
14.87	0.166	0.035	14.85	0.066	0.008	14.93	0.027	0.004	15.34	0.021	0.003			
15.88	0.147	0.033	15.85	0.072	0.009	15.93	0.034	0.004	16.35	0.021	0.003			
16.89	0.144	0.032	16.86	0.070	0.009	16.94	0.030	0.004	17.35	0.016	0.003			
17.89	0.185	0.037	17.86	0.084	0.009	17.94	0.037	0.004	18.36	0.023	0.004			
18.90	0.280	0.045	18.87	0.143	0.012	18.94	0.051	0.005	19.36	0.024	0.004			
19.90	0.390	0.054	19.87	0.171	0.013	19.95	0.053	0.005	20.36	0.014	0.003			
20.91	0.251	0.043	20.88	0.057	0.008	20.95	0.012	0.002	21.37	0.016	0.003			
21.92	0.530	0.062	21.88	0.138	0.012	21.83	0.048	0.005	21.95	0.0	0.0			
22.52	0.654	0.155	22.43	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			

TABLE 17. HELIUM-3 FROM A = 197 BOMBARDED BY 29 MEV. PROTONS.

30 DEG - RUN 23			60 DEG - RUN 27			90 DEG - RUN 16			130 DEG - RUN 21					
ENERGY (MEV)	SIGMA (NB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (NB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (NB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (NB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (NB/SR-MEV)	ERROR
13.01	0.0	0.0	12.94	0.0	0.0	13.22	0.0	0.0	13.99	0.0	0.0			
14.02	0.007	0.007	13.94	0.0	0.0	14.23	0.0	0.0	14.99	0.0	0.0			
15.02	0.0	0.0	14.95	0.0	0.0	15.23	0.0	0.0	16.00	0.0	0.0			
16.03	0.0	0.0	15.95	0.0	0.0	16.23	0.0	0.0	17.00	0.001	0.001			
17.04	0.0	0.0	16.96	0.0	0.0	17.24	0.0	0.0	18.00	0.0	0.0			
18.04	0.0	0.0	17.96	0.0	0.0	18.24	0.000	0.000	19.01	0.001	0.001			
19.05	0.0	0.0	18.97	0.001	0.001	19.25	0.000	0.000	20.01	0.001	0.001			
20.06	0.007	0.007	19.97	0.0	0.0	20.25	0.0	0.0	21.02	0.0	0.0			
21.06	0.0	0.0	20.98	0.0	0.0	21.25	0.000	0.000	22.02	0.0	0.0			
22.07	0.0	0.0	21.98	0.0	0.0	22.26	0.0	0.0	23.03	0.0	0.0			
23.08	0.0	0.0	22.99	0.0	0.0	23.03	0.0	0.0	24.03	0.0	0.0			
23.68	0.0	0.0	23.54	0.0	0.0	0.0	0.0	0.0	25.03	0.0	0.0			
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.04	0.0	0.0			
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.04	0.0	0.0			
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.05	0.0	0.0			
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.05	0.0	0.0			
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.78	0.0	0.0			

TABLE 18. ALPHA FROM A = 197 BOMBARDED BY 29 MEV. PROTONS.

30 DEG - RUN 23			60 DEG - RUN 22			90 DEG - RUN 16			130 DEG - RUN 21					
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR
12.61	0.015	0.010	12.59	0.005	0.002	12.87	0.0	0.0	13.79	0.001	0.001			
13.61	0.012	0.009	13.59	0.003	0.002	13.88	0.031	0.001	14.79	0.002	0.001			
14.62	0.015	0.010	14.60	0.003	0.002	14.88	0.033	0.001	15.79	0.010	0.002			
15.63	0.0	0.0	15.60	0.000	0.001	15.88	0.007	0.002	16.80	0.009	0.002			
16.63	0.002	0.004	16.61	0.005	0.002	16.89	0.011	0.002	17.80	0.019	0.003			
17.64	0.019	0.012	17.61	0.010	0.003	17.89	0.012	0.002	18.81	0.015	0.003			
18.65	0.049	0.019	18.62	0.021	0.005	18.89	0.015	0.003	19.81	0.015	0.003			
19.65	0.029	0.015	19.62	0.021	0.005	19.90	0.012	0.002	20.82	0.012	0.003			
20.66	0.107	0.028	20.63	0.032	0.006	20.90	0.018	0.003	21.82	0.017	0.003			
21.67	0.086	0.025	21.63	0.036	0.006	21.90	0.020	0.003	22.82	0.016	0.003			
22.67	0.107	0.028	22.64	0.049	0.007	22.91	0.024	0.003	23.83	0.012	0.003			
23.68	0.119	0.030	23.64	0.056	0.008	23.91	0.023	0.003	24.83	0.014	0.003			
24.69	0.096	0.027	24.65	0.060	0.008	24.92	0.019	0.003	25.84	0.013	0.003			
25.69	0.128	0.031	25.65	0.064	0.008	25.92	0.012	0.002	26.84	0.014	0.003			
26.70	0.132	0.031	26.66	0.061	0.008	26.92	0.016	0.003	27.85	0.004	0.001			
27.71	0.187	0.037	27.62	0.056	0.008	27.93	0.012	0.002	28.85	0.007	0.002			
28.71	0.142	0.032	28.67	0.050	0.007	28.93	0.013	0.002	29.68	0.006	0.002			
29.62	0.113	0.032	29.59	0.052	0.008	29.71	0.013	0.003	0.0	0.0	0.0			